METEOROLOGICAL CONDITIONS AFFECTING LABOR

by

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ABSTRACT

The purpose of this investigation was to identify meteorological conditions that influence the birth rate. A theory was formulated on how specific meteorological conditions would affect the birth rate. This theory was based on a review of literature. Physiological reasons for the theory were introduced.

Data were obtained at Hill Air Force Base. These data included specific new and full moon lunar phase days, barometric pressure changes, and atmospheric ionization as indexed by precipitation types. All of these variables were considered separately and as they coexist in nature as they relate to birth incidence.

The results substantiated the theory. A higher number of births occurred during conditions of full moon, barometric pressure decrease, and positive atmospheric ionization. No change in birth incidence occurred during conditions of new moon lunar phase, stable or increased barometric pressure, and neutral or negative ionization. Birth incidence was also discussed in relation to other combinations of the variables and an addition to the basic theory was suggested. This included reasoning based on the habituation response.

Because different meteorological conditions vary in other geo-

graphical locations, future investigations would include replication of this study in other areas to determine if the results are generalizable.

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CHAPTER I

INTRODUCTION

The intent of this research was to investigate probable effects of atmospheric conditions as indexed by precipitation, barometric sure and lunar phase on variations in the incidence of the initiation of labor. It is part of common medical and nursing folklore that human behavior, particularly behavior of interest to health care providers, is influenced independently and jointly by weather and lunar phase. In some countries, Hungary for example, these beliefs are put into action: bioprognoses are given with daily weather predictions.

Certain weather and lunar phase effects on human response have been documented in scientific literature. However, the relationship between atmospheric conditions and the initiation of labor has not been adequately explained, nor has it been convincingly demonstrated. Likewise, the relationship between lunar phase and the incidence of labor is mostly speculative. Nevertheless, this investigation demonstrates that a beginning theoretical explanation linking barometric pressure and lunar phase to the onset of labor can be constructed. Moreover, empirical evidence is presented by which this new line of reasoning can be assessed.

Rationale

Science proceeds with the discovery and tentative explanation of natural regularities. In this case, tantalizing clues exist that the onset of labor, as well as being the result of the physiological process called pregnancy, varies in correspondence with atmospheric and lunar conditions. Many clues are found in common folklore, others are derived from more systematic scientific investigation, but none are in and of themselves convincing. However, the persistence of the belief in the general principle that human behavior has meteorological and lunar bases and in the belief that labor in particular is one behavior affected by these dual factors, suggests that a regularity may be awaiting discovery. This then is the basic scientific justification for the study. The general understanding of human behavior may be advanced should the prediction that the relationship between and among the three key variables be supported in evidence.

In like manner, human adaptation is often predicated on and seeks comfirmation of dependable empirical regularities. If basic forces and their effects can be understood, it will be possible to distribute resources so as better to align efforts and intentions with these natural occurrences. In this particular case, since it is predicted that the incidence of labor can be reliably predicted from knowledge of certain meteorological conditions, then such resources as labor and delivery personnel can be more efficiently distributed. Currently, labor and delivery rooms are staffed in a constant pattern without regard to variations in demands that might

be placed upon skilled and talented nursing personnel. At times, these staff members are overburdened with unexpectedly high demands on their expertise. At other times, they may sit prepared to render services for which there is but meager demand. If it can be shown that variations in the onset of labor can be reliably predicted from common available information, then staffing of obstetrical units can be done with greater precision and efficiency, resulting in improved patient care.

To understand the basis of the argument that meteorological conditions affect the incidence of labor, the historical perspective of this line of thinking is reviewed as it is documented in the literature. This forms the underpinnings of the development of a theory that further explains how this relationship is substantiated. Data were collected and analyzed to show if the relationship is supported empirically. Finally, the theory is reviewed as it relates to the presented evidence. Limitations and suggestions for further research are set forth.

CHAPTER II

LITERATURE REVIEW

Atmospheric Conditions, Lunar Phase and Human Behavior

Throughout the centuries, weather has been considered an important factor influencing human behavior. For instance, planting and harvesting are planned in-part according to phases of the moon, anticipated rainfall, and seasons. Inferences were made by philosophers such as Aristotle and Nietzsche, writers such as Goethe, and physicians, exemplified by Hippocrates, relating the importance of weather to conditions in everyday life. Old wives' tales implicate the full moon as the time in which babies are most frequently born (Coffin, 1973). Certain types of weather also appear in conjunction with arthritic pain and emotional depression in a predictable fashion.

Hippocrates, the Father of Medicine, believed medicine was best studied by first recognizing the relationship of the seasons to specific diseases (Landsberg, 1969; Snorrason, 1964). In particular, Hippocrates differentiated between diseases caused by divine intervention and those occurring during certain seasons and in particular climates. He may have been the first recorded authority to relate climatological changes to disease (Snorrason, 1964).

Aristotle enlarged on these theories, relating influences of the planets and stars to storms, human deaths, and time of menstruation (Snorrason, 1964; Rosen, 1979). Goethe noted that the weather had an influence on mental efficiency and Nietzsche believed that weather triggered mood swings (Rosen, 1979). Despite these intriguing claims, few of today's American physicians have examined the relationship of weather and human behavior. However, William Peterson, described as an American Hippocrates (Rosen, 1979), did investigate this relationship.

Peterson examined one set of triplets in detail to ascertain the relationship of weather fronts to changes of physiological significance. He observed that day-to-day changes in the biochemistry of the triplets were due only to changes in the weather as the rest of the environment was controlled. He related these changes to the general populace and found the biophysiological changes of the triplets predicted certain events occurring in the population at large such as psychotic admissions, births, and the sex ratio of infants conceived (Peterson, 1947; Rosen, 1979).

In research presented by meteorologists, human responses to atmospheric phenomena are discussed. It has been reported that humans with scar tissue experience pain during increased humidity because scars do not have the ability of normal tissues to expand readily in response to humidity changes. Normal tissues expand when wet and contract slightly when dry (Landsberg, 1969), which causes increased pain during humid weather when expansion is greater than normal.

The effect of weather may not be reflected in the human organism

for one or two days. Two studies (Dirnagl & Posse, cited in Rosen, 1979) examined general effects of weather changes to confirm the presence of this biometeorological lag. Dirnagle found the incidence of reported illness increased with rising temperature, falling humidity, and dropping barometric pressure. As the temperature fell and the humidity and barometric pressure rose, the incidence was lower (Rosen, 1979). Posse (Rosen, 1979) studied the occurrence of reported illness during a three month time in relationship to passage of weather fronts, weather inversions, and warm humid weather conditions. He found that particular complaints occurred frequently during certain weather patterns. Both authors conclude that one or two days passed before the effects of the weather change were experienced (Rosen, 1979).

Tromp (1973) suggested that prolonged exposure may result in habituation; that is, the human organism becomes acclimatized to a particular type of weather and responses to the stimuli are attenuated over time. In this response, the organism may react to a particular weather change in a specific way. For example, if a houseplant is put out of doors during a windstorm, it will probably die. If, however, it has been exposed previously to winds of less velocity, it has adapted and will probably survive. Habituation to weather by humans also occurs. For example, if one is brought up in a humid climate, the humidity is not nearly as noticable as when one moves into an area with high humidity after being accustomed to little humidity. Lethargy may be experienced by the human before the organism learns to cope with the new environmental condition.

This habituation response indicates that a sudden weather change elicits more response than a gradual one.

Weather forecasters in Eastern European countries accept some correlation between weather change and physiological manifestations. A bioprognosis system has been developed in Germany and Poland for the use of those in the medical field. This service can be called daily to alert physicians to "forthcoming weather changes and their likely influences on the health and illness of their patients" (Rosen, 1979, p. 213). In Hungary, this information is given with weather reports so the populace can take precautionary measures (Vigh, 1980).

Every human is affected by the atmosphere in some way. Each human carries an atmospheric weight of ten to twenty tons at any given time according to his weight and body build. As weight and surface area of each human increases, the atmospheric pressure he withstands also increases (Fast, 1979). Counterpressure exerted by the surface area equalizes the effect of the atmospheric pressure; however, in certain sealed-off portions of the body, the changes in atmospheric pressure cannot be equalized. Examples of such sealed-off areas are the joints. Rheumatoid or arthritic joints may become quite painful during changes in the atmospheric pressure. As the air pressure decreases, swelling increases, which results in perceived pain (Licht, 1964; Wolkomir, 1977; Fast, 1979). Usually a decrease in barometric pressure corresponds with an increase in humidity. Their joint effects were shown in studies with arthritic patients; symptoms increased when the barometric pressure

decreased and the humidity rose (Landsberg, 1969; Fast, 1979; Hollander & Yeostros, 1963).

Other physiological manifestations also correspond with barometric pressure and humidity changes. Migraine headaches occur most frequently during periods of decreasing barometric pressure and increasing humidity (Brezowsky, 1964; Rosen, 1979). Also during these periods, the number of white blood cells increase, the heart muscle responds better to digitalis (Fast, 1979) and industrial accidents increase (Mills, 1942).

In addition, psychological changes have been observed during periods of barometric pressure change. As the barometric pressure decreases, people become more irritable (Mills, 1942), perhaps because tissues absorb more water with increased humidity during times of barometric pressure decrease. The brain tissues swell slightly, resulting in tendencies toward emotional upset (Mills, 1942). An increased number of suicides also occurs during this time (Landsberg, 1969). Humans reflect a change in mood one or two days after certain types of weather changes. Those with unstable personalities react more noticably with increasing irritability to an increase in humidity and a decrease in barometric pressure (Rosen, 1979). When barometric pressure increases again such as after a heavy rain, man's mood improves (Mills, 1942).

The phase of the full moon as well as barometric pressure change also correlates with both physiological and psychological changes. Admissions to mental hospitals and the number of homicides increase during the full moon (Geller & Shannon, 1976). Physiological mani-

festations include the increased incidence of post-operative bleeding during the time of the full moon (Geller & Shannon, 1976; Fast, 1979). From this information, it is seen that both lunar phase and barometric pressure changes affect the human in particular physiological ways. Thus, lunar phases should be considered along with barometric pressure when exploring the impact of weather on humans.

Barometric Pressure, Lunar Phase and Labor: Research Findings

Jacobs of Berlin reported variations in birth relating to weather changes, particularly to changes in barometric pressure (Jacobs, 1933; Peterson, 1947). Mills (1942) also observed that occurrence of childbirth increased during days of barometric pressure decrease.

A barometric pressure decrease is usually linked with a rise in relative humidity, but the preceding authors did not allude to an additional relationship between birth incidence and relative humidity. Premature rupture of the membranes, which can be influenced by weather changes, may be one factor in the initiation of labor. In fact, labor will be initiated in 80-90% of term pregnancies by spontaneous rupture of membranes (Oxorn & Foote, 1980).

In order to determine which factor, barometric pressure decrease or increased relative humidity, was more closely linked to premature rupture of membranes, research was conducted with found that no relationship existed between an increase in relative humidity and premature rupture of membranes. The primary factor linked with rupture of the membranes was a decrease in barometric pressure (Milingos,

Messinis, Diakomanolis, Aravantinos, & Kaskarelis, 1978). On the basis of this work, barometric pressure decrease is considered a possible indicator of labor and subsequent birth.

Turowski and Pawlowska (1965, from English summarization) reported more labors occurring during periods of decreased barometric pressure. Landsberg (1969) stated that labor starts during periods when warm moist air increases in the lower cloud layer, barometric pressure falls, and clouds thicken. In these periods, precipitation is common and wind velocity increases. These are the times of approaching storm. A decrease in barometric pressure resulting in storms, particularly hurricanes, may also occur more frequently during the full moon (Geller & Shannon, 1976).

Changes in the phase of the moon were found to influence birth incidence according to a five year study by Schnurman (1949). He found that births occurred most frequently on the day before, the day of, and the day following the beginning of each lunar phase, and, in addition, most births occurred in the first quarter in three of the five years observed.

Drewes (1969) reported in a one year investigation that the first three days of each lunar phase are critical days in the determination of birth incidence. Approximately forty-one percent of the births in his sample occurred on these designated days; however, these days total 144 days of the year which is also approximately forty-one percent of the total days studied. Yet, he believed the data showed a relationship between births and change of lunar phase.

Menaker (1959) used the mean synodic lunar phase, the period of

time between new moon to new moon consisting of 29.5 days, to study the relationship of births to particular days in the lunar cycle. He focused on the day before, the day of, and the day after a phase change as critical days. He sampled 120,000 births during thirteen lunar months from January 1954 through January 1955. Seven percent more births than the average occurred during the three day full moon period. The fewest births occurred during the three day new moon period. As the new moon occurred on more than one legal holiday, Menaker believed less confidence should be placed in these figures as inductions may have been initiated during the full moon period rather than the new moon because of the legal holidays.

To decrease the inappropriate effect on outcome of elective induced deliveries, Menaker (1959) used municipal hospitals rather than private hospitals as private hospitals showed marked reductions in deliveries on weekends, especially Sundays, which indicated a higher rate of elective inductions. Data included 112 lunar cycles from January 8, 1948 to January 26, 1957 and 250,000 live births. Again, the new moon was associated with the lowest birth rate and the full moon with the highest rate: 3.4% more births occurred during the full moon than the new moon period.

Menaker (1959) studied another 250,000 births during 112 lunar cycles. The half cycle beginning at day fourteen of the lunar month contained 1.6% more births than the first thirteen days. When data for both municipal and private hospitals were combined, the birth rate in the cycle beginning on day fourteen was 1.35% higher than the first thirteen days of the cycle. Only two days of the first

thirteen days had birth rates above average, one of which was day thirteen, while only two days in the last show birth rates below average. The highest birth rate was centered on the advent of the full moon phase and began two days before the full moon.

Menaker (1967) repeated his study in New York City during 1961 to 1963, the sample consisting of 501,000 live births. He found that the half cycle with the highest birth incidence began the second day of the first quarter phase. The half with the lowest incidence began the second day of the last quarter phase. The phase with the highest birth incidence occurred during the half of the lunar cycle when the most amount of light from the moon was received by the earth and the half with the lowest incidence during the time the least amount of light was received. The phase with the higher incidence is almost centered at the full moon while the lower incidence is almost centered at the new moon. The birth rate for the half centering the full moon was 1.01% higher than the half centering at the new moon.

In another projected completed in Osaka, Japan in 1975, births in relationship to the synodic lunar month were analyzed. No relationship was determined, however, it was found that the highest birth rate occurred on Tuesday and the lowest on Sunday. The authors inferred that this might be due to induction of labor (Arichi & Sakaguchi, 1979).

The most recent study was completed of a smaller sample of nearly 12,000 live and dead births at the University of California Los Angeles Hospital over a four year period. Researchers divided the

months involved into fifty-one synodic months of either twenty-nine or thirty days. The day of the full moon was designated as day fifteen. Induced births, Caesarean sections, multiple births, and stillbirths were included as well as natural live births. When all births and each particular variable were analyzed in relation to days of the lunar cycle, no correlation was shown between birth incidence and any part of the lunar cycle (Tugend, 1980).

Labor, Barometric Pressure and Lunar Phase: Theoretical Relationships

Labor and Birth

The phenomena of birth is thought to occur ten lunar months or forty weeks after the last menstrual period or nine and one-half Julian months from the time of conception. From this information, the estimated date of confinement, labor, is determined. However, less than five percent of expectant mothers go into labor at this time and less than one-half deliver within one week of the specified time period (Reeder et al., 1976). In some cases, poor recall of the last menstrual period may cause error in the calculation of the estimated date of confinement by the health care provider.

Labor is defined as "parturition; the series of processes by which the products of conception are expelled from the mother's body" (Reeder et al., 1976, p. 685). Uterine contractions in labor bring about birth. They occur because the uterus is composed of smooth muscle which has the ability to contract when stretched in absence of any other external stimulus (Ganong, 1979). Throughout

pregnancy, the uterus is stretched because of the growth of the fetus. During this time of growth, the number of smooth muscle fibers increases. As the fibers stretch, they become increasingly irritable. The irritability causes muscle spasms which result in increased muscle contractility. Because of the increased contractility of smooth muscle fibers, labor is eventually initiated (Greenhill & Friedman, 1974).

Contractions divide the uterus into different areas according to the activity of the muscle. The greatest amount of contractility is in the fundus or upper portion of the uterus. The midportion has much less contractility. The lower portion, composed of the lower uterine segment and the cervix, has little or no ability to contract. Indeed, the cervix is forced to thin out because of the effect of the stronger contracting part of the uterus drawing it up into the lower uterine segment and does not itself contract . As these fibers become shorter and thinner as a result of this drawing up process, the cervix effaces or becomes thinner and dilates which eventually allows the uterine contents to pass through the opening (Varney, 1980).

Although the primary factor in muscle contractility of the uterus is progressive stretch and irritation of the muscle fibers, other factors are implicated. Increased contractility is potentiated by the increased estrogen to progesterone ratio (Guyton, 1976; Clark & Affonso, 1979). Progesterone, which blocks myometrial contractility, decreases in amount before labor begins (Clark & Affonso, 1979). Prostaglandins, which have many diverse functions, and oxytocin,

which directly stimulates myometrial fibers, also stimulate uterine contractions (Clark & Affonso, 1979; Varney, 1980; Ganong, 1979). Calcium ions are involved in the initiation of smooth muscle contraction as they are in all muscles in the body (Ganong, 1979). The increased estrogen to progesterone ratio increases binding of the fibers (Clark & Affonso, 1979). Other theories regarding the initiation of labor include placental aging, fetal hypothalohypophyseal-adrenal activity, fetal membrane contribution, and decidual degeneration (Clark & Affonso, 1979). None of the theories of and by themselves have been substantiated totally; therefore, it has been concluded that "an unknown entity triggers labor" (Sturrock & Yeomans, 1973, p. 434).

Barometric Pressure

Barometric pressure, defined as the "weight per unit area of a column of atmosphere resting on the earth's surface" (Rosen, 1979, p. 344) may be one factor that contributes to increased contractility of the uterine fibers. It is a measure of the density of the air and varies constantly in response to changing climatological conditions. As the atmospheric density changes, a weather change is prognosticated. For example, as the barometric pressure falls, a different air mass will move into the area. As the pressure continues to fall, precipitation will follow; therefore, a decrease in barometric pressure usually corresponds to an increase in air moisture or humidity. However, this conclusion is not accurate in this geographic locale as in this area, the prefront is dry. The barom-

eter rises again as the storm passes. Different air masses with differing densities as well as dissimilar physical and chemical attributes, do not mix. The transition zone between the two masses is called a front. A warm front is one in which warm air moves "toward and over an area with cold air; thus, warm air replaces the cold air. A cold front moves "toward and usually beneath an area of warm air" (Tromp, 1973, p. 72) as the cold air replaces warm air. The cold air is higher in density, so it has to move underneath the warm air. The lowest barometric pressure reading occurs in transition between the two air masses. As discussed previously, increases and decreases in barometric pressure have been documented to have differing effects on the human organism.

Lunar Phase

Lunar phases occur due to the position of the earth relative to the moon and the sun with regard to the amount of light the moon is able to reflect to earth. The moon is closest to the earth during its full phase and farthest away during the new moon phase. The phases of the moon are divided into new, first quarter, full and last quarter lunar phases. The total cycle from new moon through last quarter lasts 29.5 days which is termed the synodic cycle. The new moon phase exists when the moon has moved into position in front of the sun so it is not seen by those on earth. As the moon rotates in a counterclockwise fashion around the earth, it takes a position 90° from that of the new moon. This is the first quarter phase where the right half of the moon is visible. The second

quarter is called the full moon. During this period, the moon is on the opposite side of the earth from the sun. If the moon and sun are in perfect alignment, a lunar eclipse can occur during this time of 180° positioning. The last quarter is opposite of the first quarter in that only the left half of the moon is viewed from earth. Rotation of 270° has now been completed. The cycle then starts again and, if the sun and moon are in perfect alignment, a total eclipse of the sun may occur.

Ions

It appears that positively charged ions predominate in the atmosphere during the full moon and storms. The moon and earth have positive ions in their atmospheres. These ions seem to effect the human body. For example, when the atmosphere contains ions which have a predominately negative charge, hypertensive patients' blood pressure will decrease. This decrease is not observable in healthy patients. When positive ions predominate, an increase in blood pressure is apparent in both hypertensive and healthy individuals (Edstrom, cited in Pavlik, 1964). Increased numbers of positive ions have also been correlated with the occurrence of lassitude, depression, migraine headache, nausea, insomnia, irritability, and respiratory problems (Sulman, 1971; Krueger, 1973 in Hawkins & Barker, 1978). Diabetics respond to positive ions with an increase in blood sugar and to negative ions with a decrease (Pavlik, 1964).

The ions present in the air that predispose these physiological changes vary in number and density according to the weather. During

a snowstorm and before thunderstorms positive ions increase in number. During and after a rain, negative ionization predominates (Reiter, 1964; Soyka, 1977; Fast, 1979). Air preceding moving weather fronts also contains positive ions (Soyka, 1977). Negative ions will attach to dust, pollution, or moisture and lose their charge which results in an increase of positive ions (Soyka, 1977; Reiter, 1964).

Ionization also changes according to the lunar phase. As the earth and moon are charged negatively, they attract positive ions to their atmospheres. During the time of the full moon, the moon is closer to the earth's atmosphere and an increase in positive ionization occurs near the earth's surface (Soyka, 1977; Fast, 1979). The top of the charged particle layer which is farthest away from the earth is positively charged. The increase in positive ions is caused because of an interaction between the positively charged portion of the ionosphere and the negatively charged earth as the moon approaches the earth (Soyka, 1977).

Not only does the atmosphere contain ions, but also body fluids, including amniotic fluid, contain ions in varying amounts depending upon the type of fluid. These fluids are composed of molecules. Each charged particle, or ion, has one or more electrical charges. In the body, positively charged particles include sodium, calcium, potassium, and magnesium; negatively charged particles include chloride, phosphate, and bicarbonate. Positively and negatively charged particles attract one another in the body as they do in the atmosphere (Burgess, 1979).

As ionization changes due to changing weather and lunar phase, the charge of the ions affects humans, as discussed previously. The amniotic fluid contained in the uterus of the expectant woman may also reflect changes because of the ionization present in the atmosphere.

Effects of Ionization on Labor

Changes occur in the concentration of ions in the amniotic fluid throughout pregnancy. Sodium ion concentrations decrease during the last half of pregnancy and chloride ion concentration either decreases or remains essentially unchanged. Although sodium and chloride concentrations usually change proportionately to each other so as one goes up or down so does the other, they are not interdependent in the amniotic fluid (Gillibrand, 1969; Hytten & Lind, 1973).

Amniotic fluid volume also changes throughout pregnancy. Closer to term, the total amount of fluid decreases (Lind et al., 1971; Hytten & Lind, 1973). This may be due to increased stratification of the fetal skin which impedes movement of fluids. The amniotic fluid is more closely related in composition to fetal plasma than maternal plasma; therefore, the fluid before midpregnancy is seen as an extension of the fetal extracellular fluid (Lind et al., 1971). During this time, fluid moves back and forth from the fetus to the amniotic fluid. As the pregnancy progresses, not only is the fluid movement restricted, but also fluid amount is decreased because of dissimilarities between maternal plasma and the amniotic

fluid composition as constituents cannot move as readily to the amniotic fluid from the maternal plasma as they could previously. The decrease in total fluid volume is more pronounced in preeclampsia (Ostergard, 1966) although preeclampsia is the result of sodium and water retention (Burgess, 1979).

Fluid volume is regulated by unknown mechanisms, and contradictions exist in the current theories. However, it is known that fetal swallowing and fetal urination are two contributing factors (Lind et al., 1971). Even after fetal death, the

> rate of turnover of the amniotic fluid is still one-half as great as it is when the fetus is normal, which indicates much of the fluid is formed and absorbed directly through the amniotic membranes. The total volume of amniotic fluid could be regulated by the amniotic membranes themselves, for as the volume increases the pressure would rise and cause increased fluid absorption thus returning the volume to normal (Guyton, 1976, p. 1115).

But it is of particular interest to note that the amniotic fluid may exchange large amounts of sodium and water with the maternal blood only by diffusion and that it primarily "behaves as a walled-off fluid" (Lind et al., 1971, p. 511).

Because the amniotic sac behaves in this fashion, an analogy can be drawn between characteristics of the amniotic sac and enclosed joints. As stated previously, joints cannot equilibrate when the atmospheric pressure decreases. The tissue and fluids in the joint expand as components such as molecules and ions move apart from each other. Similarly, during times of barometric pressure decrease, the lunar phase of the full moon, and predominately positive ionization

in the atmosphere, the contents of the amniotic fluid may expand, causing the increased hydrostatic pressure and increase myometrial contractility due to increased stretching of the muscle fibers.

The positive ions may move further apart as they are repelled from each other; therefore, the positively charged sodium ions are pushing away from the positively charged atmosphere. Not only may the ions move away from each other, but also there may be more of them to move away. All pathophysiological conditions previously discussed occurring during positive ionization in the atmosphere can be correlated in some fashion with increased fluid retention. When extracellular fluid is retained, sodium will also be retained as sodium is drawn into the extracellular fluid along with water. Because the amniotic sac obtains both electrolytes and water by diffusion and does not equilibrate (Lind et al., 1971), the increased sodium ion concentration causing the expansion of the fluid is not able to pass to the maternal circulation.

It is not known what effect changing ion charges in the atmosphere have on the amniotic fluid ionic or volume composition and therefore initiation of labor. However, it is postulated that if a retention of sodium, and increased ionic activity because of collision and repelling by positive ions, and increased fluid volume in the amniotic fluid were to occur during periods of barometric pressure decrease, the phase of the full moon, and increased positive atmospheric ionization, the increased hydrostatic pressure would then result in increasing irritability of the smooth muscle fibers of the uterus resulting in labor and subsequent birth. On

the other hand, if retention of sodium did not occur, positive ions in the amniotic fluid were not influenced by increased atmospheric ionization, and fluid volume was not influenced by a decrease in barometric pressure, labor would occur at more regular intervals. In fact, without the influence of lunar phase, barometric pressure and positive ionization, it would also be possible that the onset of labor may be delayed.

Each new factor introduced influences the onset of labor positively and a cumulative effect develops. Because it is predicted that each factor considered without the other factors has the ability to influence the start of labor, then as a second or third factor is introduced, the probability of labor is increased. If all factors co-exist, labor incidence would be higher than if only any two of these factors were present. It is also possible that all factors must be present in order for this increase in labor incidence to occur and that without this condition being met, the incidence of labor and subsequent birth may even decrease (See Figure 1).

These factors do not appear to encourage the onset of labor; in fact, the stronger each influence and the greater the number of factors present, the less likely it is that external conditions will increase the incidence of labor. The potential exists that the number of births might increase if all these factors are not present (See Figure 2).

Research Questions

The literature implicates barometric pressure decrease occurring

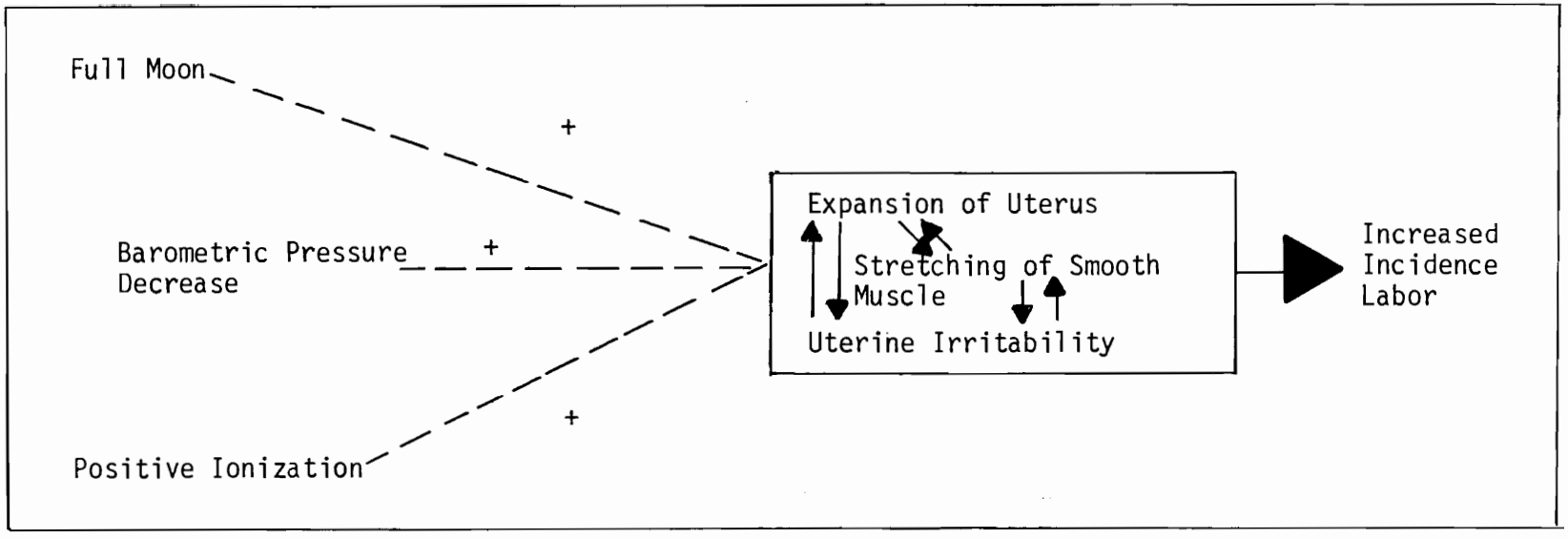


Figure 1. Illustration of Theory: Positive Influences on Labor Onset

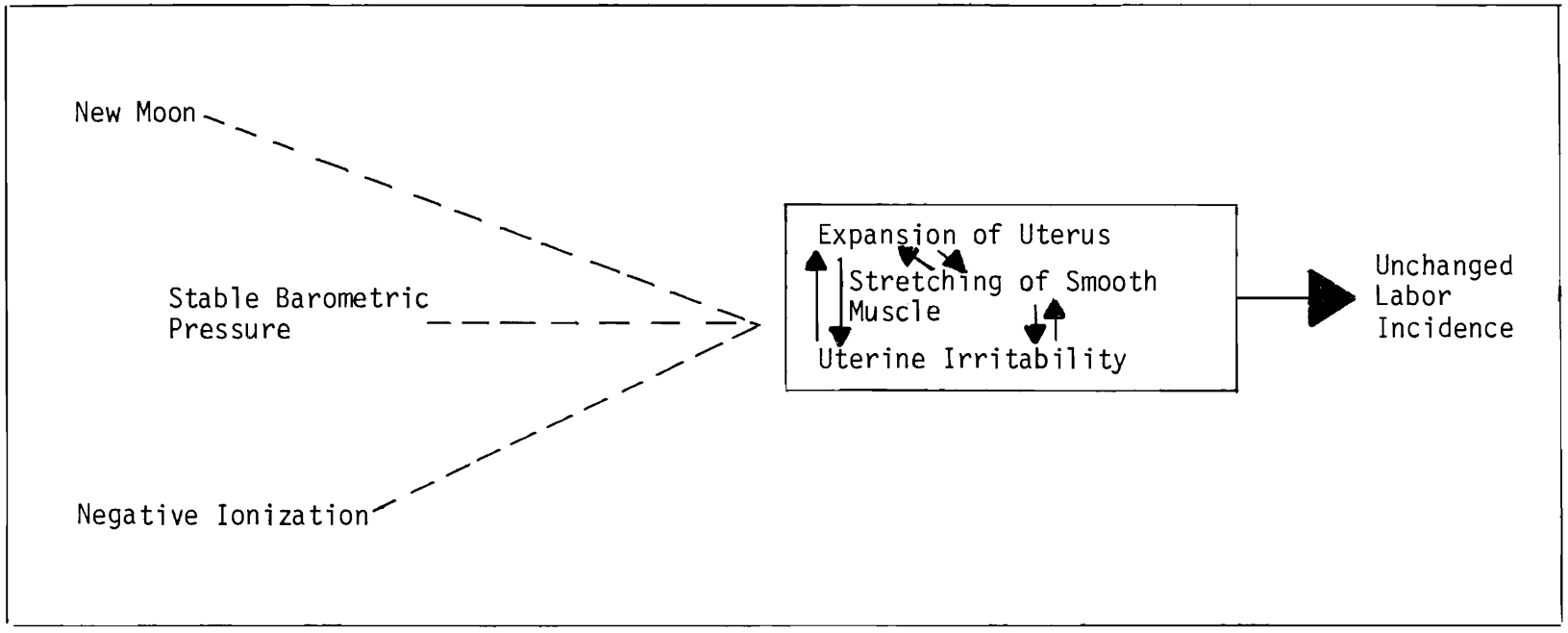


Figure 2. Illustration of Theory: Neutral Influences on Labor Onset

in relationship with the full moon lunar phase and positive atmospheric ionization. Expectations are that more labors will occur during each of these times because of these influences. Therefore, the following research question was asked:

> Do labors occur more frequently than expected during periods of sharp barometric pressure decrease, full moon, and positive atmospheric ionization?

If these influences are accepted, then it should also be accepted that stable barometric pressure, negative atmospheric ionization, and the new moon lunar phase conversely do not affect uterine changes; therefore, a second research question was asked:

> Does the number of actual labors equal the number of expected labors during periods of new moon, barometric pressure stability, and negative ionization?

CHAPTER III

METHODS AND PROCEDURES

Introduction

Several steps were necessary to begin to answer the research questions. These included identification of the methodology, the formulation of conceptual and operational definitions of the major variables, and the arrangement of the variables into an order to view and analyze possible relationships.

Research Design

The research was conducted using an ex post facto design, wherein the independent variables are not manipulated. Labors and subsequent births occur naturally. Data for each variable were collected from existing records.

This research was also correlational. It attempted to index the extent to which variables are interrelated (Polit & Hungler, 1978). If the variables were found to be interrelated, a causal relationship would not have been established, but only inferred.

Although potential problems exist in this type of study, the primary one being the lack of control by the researcher, the results may be more easily generalized than if another method had been selected (Polit & Hungler, 1978). Certainly the findings are

preliminary in nature and subject to further testing by repetition and utilization of other designs.

Whereas data were collected retrospectively, certain prospective abilities were inherent in this data analysis. Namely, the values of the independent variables could be ascertained independently of the values of the dependent variables. These values were then ordered in time, such that the sequence of events, presumed to be causes and effects, were discernible. For example, in the analysis under which full moon, a decrease in barometric pressure and positive ionization occurred jointly were identified. Subsequently the data for labor occurring during this period were properly classified. By showing different incidences of labor under different atmospheric conditions in this fashion, it was possible to address the major research questions using time-ordered values on the independent and dependent variables. Similarly it was possible to inspect variations in labor in situations other than those particular atmospheric conditions specified by the research questions. Thus, strictly speaking, the limits of most recorded studies did not manifest themselves as severe in this case. Furthermore, as cited in Chapter II, researchers in previous investigations tested for the effects of only one of the three independent variables. If all three variables do affect labor in the manner suggested, then their effects may have been masked in the cited work. In this case, the analysis allows a test of both the independent and joint effects of the three independent

variables. One other advantage should be noted. In previous research, researchers used only the absolute birth rate as an index of labor. However, since there may be seasonal or other cycles in the incidence of birth, atmospheric conditions may not, strictly speaking, be compared for effects on birth. To compensate for this problem, it is necessary to have some estimate of the expected number of births for any given period and to associate this value with variations in atmospheric conditions. In this instance data for expected births are available and figure into the analysis.

Definition of Variables

Lunar Phase

There are four lunar phases: new, first quarter, full, and last quarter lunar phases. The time of the full moon is the point of the maximum amount of moonlight received by the earth; the time of the new moon is the point of minimum light. The phase of the moon was determined from data available at Hansen Planetarium in Salt Lake City, Utah. This information included the exact time of day as well as date of each lunar phase change. The full moon was the period of time the moon was at its brightest, encompassing 36 hours either side of the hour that the most intense point of the phase was reached. The new moon was the period of time the moon was at its darkest, also encompassing 36 hours either side of the hour the phase was at its most intense point of darkness.

Barometric Pressure

Barometric pressure is the measurement of the density of the air (Burgess, 1979). Atmospheric and barometric pressure are interchangable terms. They are usually reported as a "height of a mercury colum the air pressure can support" (Rosen, 1979, p. 344). Barometric pressure is an index of various states of the weather (Landsberg, 1969) as many weather variables change simultaneously with barometric pressure (Rosen, 1979). Barometric pressure, thus, is determined by a barometer. In this case barometric pressure readings were obtained from the weather squadron at Hill Air Force Base. These readings were recorded at three hour intervals. Instruments used in collecting these data are calibrated for accuracy once yearly.

For the purposes of the study, the barometric pressure change was calculated in two ways. One was accomplished by noting the order of appearance of the highest and lowest barometric pressure readings of the calendar day of the new or full moon lunar phase. When the low reading occurred subsequently to the high, the barometric pressure decrease was calculated by subtracting the lower from the higher reading, thus determining the amount of barometric pressure decrease. The barometric pressure decrease was divided into the following categories: all barometric pressure decreases, barometric pressure decrease greater than or equal to .100 mm of mercury, barometric pressure decrease greater than or equal to .120 mm, a decrease of greater than or equal to .140 mm, and a decrease greater than or equal to .160 mm. It is likely that barometric pressure

decreases are not as severe in the intermountain area as those experienced in other geographic locales such as in the midwest or along the coast where the barometric pressure change may be more rapid and of greater magnitude in connection with tornados or hurricanes.

The second method of calculating barometric pressure change was as follows. Here the effort was to characterize barometric pressure change for the entire 72 hour period portion of each lunar phase. Barometric pressure graphs were made of each lunar phase in the study. Each graph included the barometric pressure readings every three hours for 36 hours either side of the most intense point of a lunar phase. Visual inspection of these graphs showed several similar patterns which were divided into six categories: a steady decrease, steady increase, stability, decrease followed by an increase, increase followed by a decrease, and mixed, more than one of the previous categories occurring during the same time of the lunar phase.

In order to verify the distinctions among the categories determined by visual inspection, for each graph the variance in barometric pressure was calculated. These variances were averaged. The standard deviation or the sum of all variances was calculated. Next, the variance of the differences for each graph were calculated. Again, these variances were averaged and the standard deviation was ascertained. The barometric pressure categories were then defined in terms of the standard of the average of the variances. The number .160 mm, approximately four standard deviations from the mean

variance, was selected as the value above and below which a change in barometric pressure occurred. Coincidentally, this value of .160 mm was shown in a pilot study to be associated with a higher number of births. Thus, a barometric pressure decrease was defined as a barometric pressure decrease of .160 mm or greater. An increase was defined as a barometric pressure increase during the 72 hour period of .160 mm or more. Categories of increase followed by decrease and those of decrease followed by increase were defined in a similar fashion. Stable barometric pressure was defined as one in which the barometric pressure increase and/or decrease was less than .160 mm. The net effect of these procedures was to retain all categories determined by visual inspection, save the last.

Ionization

Ionization is the electrical charge, either positive, negative, or neutral, that predominates in the atmosphere. These electrical charges occur in the atmosphere from the influences of the weather and lunar phase and are thought to instigate physiological and psychological changes in humans.

Atmospheric ionization is related to precipitation as summarized in Table 1.

In this study, ionization was determined by the type of precipitation occurring during each calendar day of each designated period as recorded by the Weather Squadron at Hill Air Force Base, Utah. Positive ionization was signified by trace amounts of rain and measurable snow. Negative ionization was indicated by

Table 1

Indices of Ionization

Predominant Ionization	Related Atmospheric Conditions
Positive	Trace of rain, measurable snow
Negative	Measurable rain
Neutral	Dust, pollution, moisture

measurable rain. Absence of precipitation was considered neutral ionization. This method of categorization was chosen because the literature suggests a correlation between ionization and specific weather conditions in that electrical activity found before and during snows indicates evidence of positive ionic activity and the absence of this activity indicates negative or neutral ionization. Neutral atmospheric ionization other than that occurring when no precipitation occurred could not be determined as dust or pollution indexes were not available at the Weather Squadron. Equipment for more precise measurement of positive, negative, or neutral atmospheric ionization and their concentrations was not available.

Labor

As stated previously, theories on how labor is initiated vary widely. All the factors included in these various theories may contribute to the natural onset of labor, alone or in conjunction with others. The commonly accepted definition postulates that true labor occurs with progressive dilation and effacement of the cervix. However, this definition is limiting in that many dysfunctional labors where this does not consistently occur are excluded, although regular contractions of the uterus may be present.

For purposes of this investigation, labor was defined imprecisely as the period of time that uterine contractions are experienced that lead to the birth of a baby. It is not usual for labor to persist longer than 24 hours before birth occurs (Oxorn & Foote, 1980). It is known that usually the time of labor decreases as

parity increases. Exceptions to this are found in cases or abnormal fetal presentations, labor abnormalities, grand multiparity, maternal or fetal physiological disorders, and after administration of analgesics or anesthetics to laboring mothers. It was assumed that the births occurred due to labor beginning 24 hours or less before the time of birth.

Labor was indexed by the birth of an infant. Births included were those occurring after spontaneous onset of labor. This was determined by progressive dilatation and effacement of the cervix resulting from uterine contractions without influence of synthetic oxytocin preparations utilized in the initiation of these contractions. These contractions resulted in the birth of a baby. Births were also included that resulted from spontaneous rupture of the amniotic sac whether or not labor was induced or augmented with oxytocics.

Labor was calculated in two ways. The first was to record the absolute number of births that occurred each calendar day for each 72 hour lunar phase. Additionally, labor was calculated by a ratio of actual to expected births. The actual births were those previously described. An expected birth was one that was forecasted to occur 267 days after conception or 280 days from the last menstrual period (Oxorn & Foote, 1980). The total number of births expected to occur during the 24 month period of data collection were tabulated from available records at USAF Hospital Hill. The same records were used to determine the total number of expected births for each calendar day of the lunar phase under consideration. The number

of expected births was important in observing any deviation from the normal. If a greater number of births were expected during a particular time, this fact alone would bias the findings. By adjusting the actual births in relation to the expected births, no period would be artificially favored. However, if few births were expected and a large number did, in fact, occur, again a meteorological variable was inferred. The major difficulty existed in using the number of expected births as part of an index of labor in that these estimated dates are notoriously unreliable. Calculations made by the care provider might be wrong due to a variety of reasons. These reasons commonly include conception occurring at times other than fourteen days after the beginning of the last menstrual cycle or the inability of the expectant women to recall the date of the beginning of her last menstrual period. The estimated date of delivery may also be in error due to reasons other than miscalculation by the health care provider, but these reasons are presently unknown. A term pregnancy is one that lasts somewhere between 38 and 42 weeks, not exactly 280 days, and many births occur before or after that number of weeks, so it may not be possible to estimate precisely the time of birth. Regardless, the estimated dates were used for comparison to identify whether more or fewer births occurred than the number expected. It was assumed that errors in estimating expected births were randomly distributed.

Delivery information was obtained from birth records kept at USAF Hospital Hill from 1 September 1979 to 31 August 1980. Permission to use these birth records was obtained from USAF Hospital

Hill administration. Since the number of deliveries, dates and times of births are considered public information through the Bureau of Vital Statistics, maternal permission to use these data was not required. The names of those who delivered are not reported in order to protect patient confidentiality.

All actual births occurred at USAF Hospital Hill. The women who deliver at this facility are eligible for care because of military or military dependent status. Most are dependents of enlisted personnel or are themselves active-duty enlisted. These women live on base or in close proximity to the base. These characteristics make these women (who deliver at Hill Air Force Base) similar in socioeconomic status, level of risk, and most probably, in nutritional status.

Organization of Data

Figure 3 illustrates how the five types of data were combined for analysis. Considering the unit of analysis to be a lunar period, data were organized within a 72 hour period centered around the most intense hour of the phase. Thirty-six hours are located on each side of the mid-point. Over this period also plotted were the barometric pressure readings at every three hour interval. Then, according to calendar day, type of precipitation was entered onto the plot. Actual and expected births were also located by calendar day. In this fashion it was possible to visualize the time order of events. For example, in the illustration a rather sharp decrease in barometric pressure was initiated approximately 15 hours into the pressure period. The decrease reached its nadir at about the

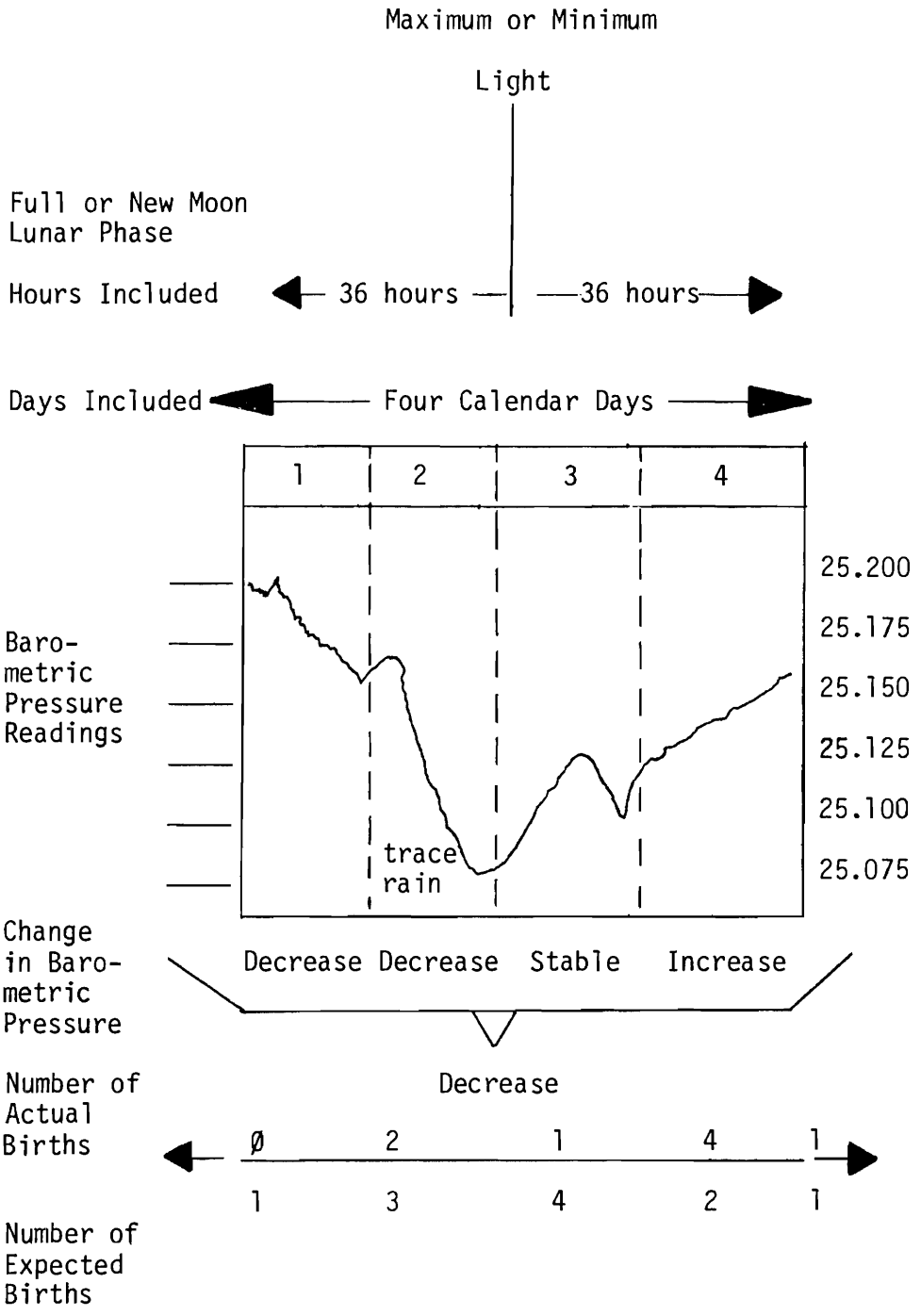


Figure 3. Data Organization for Calendar Day Only

36 hour interval and rose slowly after that. The absolute barometric pressure values were recorded on the right side of the plot. Also located after the 24 hour point was evidence of a trace of rain. At the bottom of the Figure are indicated both the actual and expected number of births recorded for each day. The reader should note that the birth data extended to a fifth day. This allowed testing for the effects of atmospheric conditions that might be lagged into the period beyond 72 hours. It should be noted the name of the phase, new or full, could be placed at the top of the plot. In this manner it was possible to locate events in time. The advantages were obvious. Actual and expected births used in the analysis were taken only from that part of the plot which corresponded to or followed the points at which precipitation and barometric changes were noted.

It is also possible to see how one can alter the unit of analysis from the lunar period to a calendar day. This procedure was followed as will be discussed in the next Chapter. Essentially the only difference is to measure barometric pressure change in terms of any increases or decreases that occur within a calendar day. The use of a calendar day is admittedly arbitrary since atmospheric effects, if they are to occur, are not limited by time measurement conveniences. Nonetheless, the fact remains that births, expected births, and precipitation are recorded in terms of calendar days. Thus, however arbitrary, the calendar day as the unit of analysis has certain traditional advantages.

By so organizing the data for analysis it seems likely that

several of the more serious limitations of records study can be overcome. Namely, within certain limits, the sequence of events can be ascertained such that births that may have occurred before any change in barometric pressure or the occurrence of some form of precipitation are not treated as if they had, in fact, followed these events. Nor as can readily be seen, are the researchers constrained by the supposed interrelatedness of atmospheric conditions. Should it occur, as it does, that precipitation occurs when barometric pressure remains stable or increases, then the effect of alterations in covariations among the independent variables can be observed.

CHAPTER IV

PRESENTATION OF FINDINGS

The findings are presented in two ways. First, the unit of analysis was a calendar day. Each calendar day was classified according to the barometric pressure decrease that occurred. A decrease was recorded when the highest barometric pressure reading occurred early in the day with the lowest occurring subsequently in that same day. Barometric increase days were not included. Barometric pressure decrease days included all those where the decrease exceeded or equalled retrospectively .160 mm, .140 mm, .120 mm, .100 mm, .060 mm, .040 mm, and .020 mm of mercury. These days were further categorized according to lunar phase and type of precipitation. In this initial section of the analysis, absolute births alone were considered. Analysis was then repeated using the ratio of actual to true expected births. The independent and joint effect of the three independent variables were illustrated through this analysis. By using the second approach, the unit of analysis was an entire 72 hour lunar phase. Through this analysis, each phase was described in terms of lunar phase, the overall pattern of barometric pressure change, and precipitation type. Here, labors were defined only in terms of the ratio of actual to expected births. Once again, the independent and joint effects of the independent variables were

illustrated. In contrast to the first analysis strategy which is entirely descriptive, here, inferential statistics were utilized. It must be recognized that weather is composed of many factors. Barometric pressure, lunar phases, and precipitation or atmospheric ionization are only a few of these factors and were selected as the most common indicators of weather trends. These factors may not be accurate indicators of birth incidence. Other factors such as wind velocity, humidity, and cold or warm air fronts may also be implicated.

Geographic location may have affected the results as the intermountain area of the Wasatch Front does not experience the same types of weather that the Midwest and Coastal areas do. Although a large majority of the expectant women lived on base or in the immediate area adjacent to USAF Hospital Hill, the sample did include some subjects residing outside this immediate area. It is not known what effects differing altitudes or proximity to either the mountain or bench areas may have or whether these effects could have influenced the results.

Part I: Average Births Per Day

The findings relative to average births per day are presented in Table 2. In the far left column, the two lunar phases are indicated as N.M. (new moon) and F.M. (full moon). The second column from the left reflects the category of barometric pressure decrease in which any particular day was classified. The right-hand columns show different types of precipitation. Cell entries are the average

Table 2

Average Births Per Day

	Any BP Decrease	Any Precip	BP Decrease Any Precip	Tr Rain	Tr Rain BP Decrease	Measur-able Rain	Rain BP Decrease	Tr Snow	Tr Snow BP Decrease	Measurable snow	Snow BP Decrease	Tr Snow Measurable Rain	Tr Snow, Rain BP Decrease
N.M.	1.479	1.561	1.789	1.571	2.0	1.444	1.053	1.5	1.0	1.5	1.0	2.333	2.5
F.M.	1.104	1.375	1.174	1.833	1.286	0.909	1.25	1.556	2.0	1.875	1.0	Ø	Ø
	$BP\downarrow \geq .160$												
N.M.	1.666		1.0		Ø		Ø		Ø		1.0		Ø
F.M.	1.167		0.667				1.0		0.5		2.0		Ø
	$BP\downarrow \geq .140$												
N.M.	1.583		1.625		Ø		2.0		1.0		1.0		Ø
F.M.	1.4		0.6		1.333		1.0		0.5		1.0		Ø
	$BP\downarrow \geq .120$												
N.M.	1.529		1.778		3.0		1.2		1.0		1.0		2.0
F.M.	1.318		0.857		1.0		1.0		0.5		1.0		Ø
	$BP\downarrow \geq .100$												
N.M.	1.625		1.714		2.0		1.857		1.0		1.0		2.5
F.M.	1.318 NC		1.091		1.8		1.333		0.5		1.0		Ø
	$BP\downarrow \geq .080$												
N.M.	1.447		1.875		1.75		1.0		1.0		1.0		2.5
F.M.	1.212		1.538		1.333		1.25		2.0		1.0		Ø
	$BP\downarrow \geq .060$												
N.M.	1.409		1.824		1.75		1.053		1.0		1.0		2.5
F.M.	1.11		1.174		1.286		1.25		2.0		1.0		Ø
	$BP\downarrow \geq .040$												
N.M.	1.489		1.833		1.75		1.053		1.0		1.0		2.5
F.M.	1.086		1.174		1.286		1.25		2.0		1.0		Ø
	$BP\downarrow \geq .020$												
N.M.	1.479		1.789		1.75		1.053		1.0		1.0		2.5
F.M.	1.104		1.174		1.286		1.25		2.0		1.0		Ø

Total Actual Births:	Total Days:	Total Births Per Day:
New Moon 123	New Moon 100	New Moon 1.23
Full Moon 117	Full Moon 100	Full Moon 1.17

number of births for all days that met the accepted atmospheric conditions.

Lunar Phase

There were 200 calendar days, 100 in each of the new and full moon phases. Also, for these 300 days, there were 240 births; 123 occurred during a new and 117 occurred during the full moon. Thus, the average number of births per day for these 200 days was 1.2. The daily average for the new moon was 1.23 and for the full moon the average was 1.17 births per day. It appears that there is no important lunar effect. However, after perusing the Table, the appearance of a decided lunar effect appears to occur under certain atmospheric conditions.

Barometric Pressure Decrease

The average births per day of any barometric pressure decrease was 1.222, essentially the same as the overall average births per day. Barometric pressure decrease categories showing the highest average births per day were barometric pressure decrease greater than or equal to .160 during the new moon with average births per day of 1.666 and barometric pressure decrease greater than or equal to .140 for the new moon with average births per day of 1.4. Diminishing the size of the barometric pressure decrease did not effect the average number of births per day until the decrease equalled or exceeded .080 during the full moon. However, the birth rate was consistently higher than its overall

new moon average of 1.23 in all categories of barometric pressure decrease during the new moon.

Precipitation

Average births per day for all days in which precipitation occurred were 1.476, exceeding the overall average of 1.2 births per day. The average births per day exceeded the average number of births per day (1.2) under all precipitation types during the new moon lunar phase as well as under most precipitation types during the full moon lunar phase. The greatest effect on birth incidence in the full moon lunar phase was demonstrated in the precipitation categories of "trace of rain" and "measurable snow," where 2.33 births, on the average were recorded each day. Under two conditions, "trace of rain" and "measurable snow" the average number of daily births favored the full moon. Very little difference occurred between the two lunar phases during days with "trace of snow."

Precipitation was recorded for each 24 hour period. Consequently, it was not possible to know exactly when during the calendar day that the precipitation occurred. This knowledge may have altered the outcome as births may have occurred prior to the precipitation. Accurate timing of births in relationship to the time and amount of precipitation, as well as the precipitation type, would have facilitated a more precise analysis of causal ordering of the key variables.

Barometric Pressure/
Precipitation

The average births per day when a barometric pressure decrease was combined with any type of precipitation was 1.452, a value in excess of the average number of births (1.2).

New Moon/Barometric Pressure
Decrease/Precipitation

A comparison of births occurring during any barometric pressure decrease with those occurring with any barometric pressure decrease in conjunction with types of precipitation revealed that the average births occurring during the new moon lunar phase was 1.789. This is an increase from births occurring during all days of barometric pressure decrease alone (1.479) and from births occurring during days of all precipitation combined (1.561). When the average number of births per day occurring during the particular type of precipitation were compared to those occurring during barometric pressure decrease alone, it was found that no particular difference occurred between the two, with the exception of "trace of snow" combined with "measurable rain." The average number of births per day was 1.479 with any barometric pressure decrease and was 2.333 when a trace of snow and rain occurred on the same day.

Next, specific types of precipitation in combination with any barometric pressure decrease were compared. Those showing an overall increase in average births per day were "trace of rain" and "trace of snow," combined with "measurable rain," both types associated with any barometric pressure decrease. Lower birth inci-

dence was found with precipitation types combined with any barometric pressure decrease of "measurable rain," "trace of snow," and "measurable snow."

A comparative analysis then compared specific barometric pressure decreases alone, in association with all types of precipitation, and finally, with specific types of precipitation. A comparison between precipitation alone and that same precipitation occurring with a specific barometric pressure decrease were also made.

Barometric pressure decrease greater than or equal to .160 (1.666). The average number of daily births with all types of precipitation was 1.0. This did not vary among the specific types of precipitation. It should be noted that no days fit this barometric pressure decrease category and precipitation type in the "trace of rain," "trace of snow," "measurable rain," or "trace of snow with measurable rain" categories.

Barometric pressure decrease greater than or equal to .140 (1.583). The average number of births per day was highest only when "measurable rain" was combined with a barometric pressure decrease (2.0), as compared to those births occurring during only barometric pressure decrease (1.583). The same was true when "measurable rain" with a barometric pressure decrease (2.0) was compared to the average births occurring during the precipitation alone (1.444). There were no cases of barometric pressure decrease as combined with "trace of rain," or "trace of snow" combined with "measurable rain." As a whole, no increase or decrease in births were observed when any precipitation type (1.625) combined with the barometric

pressure decrease.

Barometric pressure decrease greater than or equal to .120 (1.529). The average number of births per day were higher when the barometric pressure decrease combined with precipitation types "trace of rain" and "trace of snow with measurable rain"(2.0). A smaller average was observed in other precipitation types. Average births per day were slightly higher when barometric pressure decrease was considered alone to when it combined with any precipitation (1.778). The same higher average occurred after barometric pressure decrease combined with precipitation (1.778) as compared to those occurring during precipitation alone (1.561); however, the birth rate became slightly lower from "trace of snow with measurable rain" (2.333) when the barometric pressure decrease (2.0) was added.

Barometric pressure decrease greater than or equal to .100 (1.625). A higher average number of births occurred when precipitation types "trace of rain," (2.0) "measurable rain," (1.857) and "trace of snow combined with measurable rain" (2.5) were observed in conjunction with barometric pressure decrease. More average births occurred in both precipitation types "trace of rain" (2.0) and "measurable rain" (1.857) when compared to precipitation without the barometric pressure decrease (1.571 and 1.444). A higher average was also noted when "trace of snow" was combined with "measurable rain" and the barometric pressure decrease (2.5). Any precipitation type with rain (2.0, 1.857, 2.5) showed greater average births per day in combination with the barometric pressure compared to the average births occurring during each precipitation type

alone (1.571, 1.444, 2.333, respectively).

Barometric pressure decrease greater than or equal to .080 (1.447). In this category, "trace of rain," (1.75) and "trace of snow with measurable rain" (2.5) showed a higher number of births. Again, this influenced the birth rate to become higher in this barometric pressure category in combination with any precipitation (1.875). These same precipitation types when combined with the decrease in barometric pressure showed a higher number of average births when compared to precipitation types with the barometric pressure decrease deleted (1.571, 2.333).

Barometric pressure decrease greater than or equal to .060 (1.409). A greater number of average births per day occurred with the same precipitation types when combined with barometric pressure decrease and compared to those occurring during barometric pressure decrease or precipitation types alone. The ratios were unchanged from the previous barometric pressure decrease category.

Barometric pressure decrease greater than or equal to .040 (1.489) and .020 (1.479). The same pattern of increases and decreases in the average number of births per day occurred as in the previous two barometric pressure decrease categories.

Full Moon/Barometric Pressure Decrease/Precipitation

The average number of births per day during the full moon (1.17) became greater when a barometric pressure decrease was combined with precipitation of "measurable rain" (1.25) and "trace of snow" (2.0); however a lower number of births was noted in all other precipita-

tion types combined with a barometric pressure decrease. As a whole, the average number of births per day was greater when any precipitation alone (1.174) was considered as compared with those occurring during any barometric pressure decrease alone (1.104). Neither of these averages, however, differed significantly from the total average births per day occurring during the full moon lunar phase (1.17).

An opposite effect of that reported during the new moon was noted as the average number of births per day became higher when barometric pressure decrease was combined with precipitation "measurable rain" (1.25), and "trace of snow" (2.0). This was compared with births occurring during the precipitation alone (0.909, 1.556). A smaller average number of births per day was observed when barometric pressure combined with precipitation "trace of rain" (1.286) and "measurable snow" (1.0). This was compared to the precipitation occurring without taking the barometric pressure decrease into account (1.833, 1.875).

Average births per day were compared during specific barometric pressure decreases alone in combination with precipitation as a whole Also, comparison was made between these specific barometric pressure decreases and precipitation when separated into types and with the individual precipitation types alone.

Barometric pressure decreases greather than or equal to .106 (1.167). When precipitation occurred in combination with a barometric pressure decrease (0.667), the average births per day lessened except when "measurable snow" was combined with the barometric pressure decrease (2.0). The average births remained the same or became less in this

category of barometric pressure decrease combined with all precipitation types when they were compared with those occurring during precipitation types considered alone. No cases were observed in times of "trace of rain" or "trace of snow with measurable rain" when both were combined with a barometric pressure decrease.

Barometric pressure decrease greater than or equal to .140 (1.583). No change or a smaller number of average births were observed when barometric pressure decrease combined with precipitation was compared to those occurring during a barometric pressure decrease alone. Higher rates of average births did not occur when barometric pressure decrease combined with precipitation was compared to those occurring with precipitation alone.

Barometric pressure decrease greater than or equal to .120 (1.529). The average number of births per day lessened when barometric pressure decrease was combined with all precipitation types (0.857) compared with those occurring during the pressure decrease alone (1.318). No perceptible differences were observed in births per day when barometric pressure decrease was combined with "measurable rain" (1.0) as compared with those occurring during the precipitation alone (0.909). All other cases evidenced smaller average number of births when precipitation occurred with a barometric pressure decrease as compared to those occurring during precipitation alone.

Barometric pressure decrease greater than or equal to .100 (1.318). All cases of births per day were similar to those in the category of barometric pressure decrease greater than or equal to .120 with two exceptions; higher average when barometric pressure decrease was

combined with the precipitation type "trace of rain" (1.8) and no change when barometric pressure decrease was combined with "measurable rain" (1.333). In contrast, when these types of precipitation occurring in conjunction with barometric pressure decrease were compared, instead, to precipitation alone, the average number of births per day changed little during "trace of rain" (1.833, 1.8), but increased during "measurable rain" (0.909, 1.333).

Barometric pressure decrease greater than or equal to .080 (1.212). The average number of births per day were higher when any precipitation (1.538) or "trace of snow" (2.0) was combined with a barometric pressure decrease. Very little change was noted when the barometric pressure decrease was combined with "trace" (1.333) or "measurable" amounts of rain (1.25). Smaller numbers of average births occurred during "measurable snow" (1.0). When precipitation types alone were compared to precipitation types in conjunction with a barometric pressure decrease, a higher number of average births occurred during all precipitation types combined (1.375, 1.538), with "measurable rain" (0.909, 1.25), and with "trace of snow" (1.556, 2.0).

Barometric pressure decrease greater than or equal to .060 (1.11), .040 (1.086), and .020 (1.104). A higher number of average births per day were seen when the barometric pressure decrease was combined with "trace of snow" (2.0) as compared to those births during a barometric pressure decrease alone. All others changed only slightly. The birth rate was less when all precipitation types with a barometric pressure decrease (1.174) or "trace of rain" with barometric

pressure decrease (1.286) were compared to those occurring during precipitation types alone (1.375, 1.838), but was greater during precipitation types "measurable rain" (1.25) and "trace of snow" (2.0) when compared with precipitation alone (0.909, 1.556).

Summary

Lunar phase. The new moon and full moon lunar phases showed approximately equal numbers of average births per day (1.23, 1.17).

Barometric pressure decrease. A barometric pressure decrease was associated with higher average numbers of births per day during the new moon lunar phase in all categories of barometric pressure decrease.

Precipitation. Precipitation did affect birth incidence, especially when combined with barometric pressure decreases.

Conclusion

New Moon. A particularly high or low average number of births per day were seen when lunar phase was considered alone. When barometric pressure decrease greater than or equal to .100 mm occurred, the average number of births per day was higher. All types of precipitation except that of "measurable rain," reflecting a low average number of births per day, indicated a higher number of births per day than the average number of births per day would be without any consideration of variables. The average daily births became still larger when precipitation was combined with a barometric pressure decrease. This higher number of births was best indicated during a barometric pressure decrease greater than or equal to .100 and during preci-

"trace of rain" and a "trace of snow with measurable rain." It is also noteworthy that the precipitation type "measurable rain" showed a higher average number of births during periods of barometric pressure decrease $\leq$ .100, although as a whole, when barometric pressure decrease was combined with "measurable rain" no higher number of births were recorded.

Full Moon. The average number of births per day were only slightly lower than the average number of births per day would be if lunar phase were not considered. When barometric pressure decrease without precipitation was considered, a higher number of births were shown only after a barometric pressure decrease of greater than or equal to .100. However, this higher average number of births was not as high as those averages occurring during the new moon lunar phase. When births occurring during precipitation alone were considered, the average number of births per day increased during "trace of rain," "trace of snow," and "measurable snow."

Interestingly, the average number of births per day became less when both precipitation and barometric pressure decrease were combined in all cases but one. This case occurred when precipitation of "measurable rain" was present and the barometric pressure decrease was greater than or equal to .100. However, this average varied little from the average number of births per day occurring during the days of barometric pressure decrease of greater than or equal to .100 without considering type of precipitation.

Summary

During the new moon lunar phase, a higher number of average

births occurred when barometric pressure decrease and precipitation were considered independently. The effect was more pronounced when considered jointly during precipitation types "trace of rain" and "trace of snow with measurable rain" although the latter precipitation type contained too few days from which to make significant generalizations. During the full moon lunar phase, a higher number of average daily births also occurred, but not with the same magnitude as during the new moon lunar phase. In fact, a higher number of average births only occurred with precipitation type "trace of rain" and barometric pressure decrease greater than or equal to .100 and during "trace of snow" with the barometric pressure decrease greater than or equal to .080.

Thus, the data indicate the precipitation type most closely associated with a higher average of births is "trace of rain" and the most important barometric pressure decrease is one that is greater than or equal to .080. These factors do seem important during the new moon lunar phase, but also contributed to birth incidence during the full moon lunar phase.

Ratio of Actual to Expected Births Per Calendar Day

Using the same method of analysis, actual average births per day were replaced by the ratios of actual to true expected births. During the period studied, 942 births were expected but only 862 occurred. Overall then, the daily ratio of actual to expected births was .915. Under certain atmospheric conditions, however, some rather extreme departures from this overall ratio were observed.

Thus, in contrast to calculations using the average of actual daily births, there appears to be a more pronounced lunar and meteorological effect, especially under conditions of rain and or snow, depending upon the size of the barometric pressure decrease and the lunar phase. Table 3 summarizes the results of the analysis examining the ratio of actual to expected births.

Lunar Phase

During the 24 month period, 942 births were expected compared to 862 births which actually occurred. Thus, the ratio of actual to expected births for the entire period was .915. The new moon actual to expected ratio was 1.183, the full moon 0.090, thus the new moon lunar phase showed a higher ratio of actual to expected births. The ratio for the full moon was approximately the same as for all lunar phases combined.

Barometric Pressure Decrease

The largest ratio of actual to expected births was found in the new moon lunar phase during daily barometric pressure decreases greater than or equal to .160 (3.333). The largest ratio in the full moon was during times of barometric pressure decrease of greater than or equal to .140 (1.40). As a whole, the new moon lunar phase showed a larger ratio than did the full moon. The new moon's birth ratio was 1.578 compared to the full moon's of 1.039. Without considering lunar phase, in all conditions of barometric pressure decrease, the total average ratio of births was 1.211, somewhat higher than .915, the overall value.

Table 3

Total Actual to Expected Births Per Day

Lunar Phase	BP Decrease	Any Precip	BP Decrease Any Precip	Tr Rain	Tr Rain BP Decrease	Tr Snow	Tr Snow BP Decrease	Measur-able Rain	Rain BP Decrease	Measur-able Snow	Snow BP Decrease	Tr Snow Mea-surable Rain	Tr Snow Rain BP Decrease
N.M.	1.578	1.6	1.36	1.833	2.667	1.2	1.0	1.363	2.0	2.0	4.0	3.5	5.0
F.M.	1.039	1.018	1.688	2.0	2.25	0.636	0.75	0.714	5.0	1.154	1.5	Ø	Ø
	$BP_{\downarrow} \geq .160$												
N.M.	3.333		0.5		Ø		Ø		0.25		2.0		Ø
F.M.	.778		0.222				0.1		1.0		0.5		Ø
	$BP_{\downarrow} \geq .140$												
N.M.	1.727		1.625		Ø		2.0		2.0		2.0		Ø
F.M.	1.40		2.167		2.0		0.1		1.0		0.5		Ø
	$BP_{\downarrow} \geq .120$												
N.M.	1.733		1.778		1.0		0.5		1.2		4.0		4.0
F.M.	1.381		0.60		2.0		0.1		1.0		0.5		Ø
	$BP_{\downarrow} \geq .100$												
N.M.	1.857		1.09		2.0		1.0		1.625		4.0		5.0
F.M.	1.381		1.273		3.0		0.1		4.0		0.5		Ø
	$BP_{\downarrow} \geq .080$												
N.M.	1.571		1.304		2.33		1.0		2.0		4.0		5.0
F.M.	1.212		1.429		2.0		0.857		5.0		0.5		Ø
	$BP_{\downarrow} \geq .060$												
N.M.	1.016		1.292		2.333		1.0		2.0		4.0		5.0
F.M.	1.0		1.8		2.25		0.857		5.0		1.5		Ø
	$BP_{\downarrow} \geq .040$												
N.M.	1.591		1.32		2.333		1.0		2.0		4.0		5.0
F.M.	1.0		1.8		2.25		0.857		5.0		1.5		Ø
	$BP_{\downarrow} \geq .020$												
N.M.	1.578		1.36		2.333		1.0		2.0		4.0		5.0
F.M.	1.039		1.668		2.25		0.75		5.0		1.5		Ø

Total Actual Births:	Total Expected Births:	Ratio of Total Actual to Total Expected Births:
New Moon 123	New Moon 104	New Moon 1.183
Full Moon 117	Full Moon 130	Full Moon 0.90

Precipitation

The ratio of actual to expected births for both the new and full moon lunar phases combined was 1.260, again somewhat above the overall ratio. A high ratio was observed in all precipitation types during the new moon lunar phase. The higher ratios during the full moon were found in only precipitation types "trace of rain" (2.01) and "measurable snow" (1.154). Under "trace of snow" (.636) and "measurable rain" (.714) the full moon ratio was decidedly low. No days occurred with full moon and "trace of snow with measurable rain.".

Barometric Pressure/
Precipitation

The ratio of actual to expected births when any barometric pressure decrease was combined with any precipitation type was 1.488, which was higher than the average ratio of 0.915. More specific comparisons were made for the ratio of actual to expected births occurring during all barometric pressure decreases and precipitation types and for those during specific barometric pressure decrease and/or precipitation types.

New Moon

In general, a decrease in ratio was observed when barometric pressure decrease was combined with any precipitation (1.36) compared to the ratio occurring during precipitation alone (1.6). A decrease was also observed when "trace of snow" was combined with a barometric pressure decrease (1.0) compared with this precipitation type without barometric pressure decrease (1.2) considered. A high ratio

was noted when precipitation types "trace of rain" (2.667), "measurable rain" (2.0), "measurable snow" (4.0), and "trace of snow with measurable rain" (5.0), were combined with any barometric pressure decrease compared with the ratio of the precipitation type alone (1.833, 1.368, 2.0, 3.5).

Barometric pressure decrease greater than or equal to .160 (3.333). The ratio when this barometric pressure category alone was considered was higher than the ratio found when the decrease was combined with any type of precipitation (0.5). When the ratio during any precipitation type and barometric pressure decrease were compared with the precipitation type alone, it was found that all ratios decreased, the higher ratio belonging to that of precipitation alone (1.6). No cases were included in the precipitation types "trace of rain" or "trace of snow with measurable rain."

Barometric pressure decrease greater than or equal to .140 (1.727). The ratio of births found with precipitation in combination with a barometric pressure decrease (1.625) showed only a slightly higher ratio than that of barometric pressure decrease without considering precipitation (1.727). No cases were present for "trace of rain" or "trace of snow with measurable rain." The barometric pressure decrease contributed nothing to "measurable snow" as this ratio remained unchanged (2.0); however, all other types of precipitation when combined with barometric pressure decrease showed a higher ratio than when precipitation alone was considered.

Barometric pressure decrease greater than or equal to .120 (1.733). No increase in the ratio of actual to expected births was observed

when barometric pressure decrease alone was compared to all types of precipitation with the exception of "measurable snow" (4.0) and "trace of snow combined with measurable rain" (4.0) in which the ratio was substantially higher. A lower ratio was noted in precipitation types "trace of rain" (1.0) and "trace of snow" (0.5) combined with barometric pressure decrease as compared with the ratio of precipitation type alone (8.833, 1.2). The ratio remained essentially the same when barometric pressure decrease and "measurable rain" (1.2) were compared to "measurable rain" alone (1.368).

Barometric pressure decrease greater than or equal to .100 (1.857). A slightly higher ratio was observed from that found in barometric pressure decrease alone when compared to "trace of rain" with the barometric pressure decrease (2.0). A substantially higher ratio was found in the precipitation types "snow" (4.0) and "trace of snow with measurable rain" (5.0) in combination with a barometric pressure decrease as compared to barometric pressure decrease alone. "Trace of snow" with barometric pressure decrease (1.0) showed a lower ratio as compared to that of a barometric pressure decrease alone. An increase was noted when comparing "trace of rain" (2.0), "measurable rain" (1.625), "measurable snow" (4.0), and "trace of snow with measurable rain" (5.0), all types combined with barometric pressure decrease, to the precipitation without the barometric pressure decrease (1.833, 1.368, 2.0, 3.5).

Barometric pressure decrease greater than or equal to .080 (1.571). A decrease was observed in the ratio when precipitation type "trace of snow" with barometric pressure decrease (1.0) was compared

to barometric pressure decrease alone as it was obvious that precipitation diminished the ratio. The ratio increased in all other specific precipitation types. When ratios occurring in cases of both precipitation and barometric pressure decrease were compared to those occurring during the precipitation alone, an increase in ratio was found in all categories of both precipitation and barometric pressure decrease, except "trace of snow" with the barometric pressure decrease (1.0).

Barometric pressure decrease greater than or equal to .060 (1.016), .040 (1.591), .020 (1.578). The only ratio that differed from that found in the barometric pressure decrease category previously discussed was that in "trace of snow" (1.0) which was essentially equal to that ratio found in viewing barometric pressure decrease alone when the barometric pressure decrease was greater than or equal to .060.

Full Moon

When a barometric pressure decrease was combined with precipitation, an increased ratio was found in all cases except that of "trace of snow" in combination with barometric pressure decrease (0.75). An increased ratio was found in all cases of precipitation in combination with a barometric pressure decrease as compared with the precipitation type alone. No cases were observed during the full moon with "trace of snow with measurable rain."

Barometric pressure decrease greater than or equal to .160 (0.778). A decrease or no change in the ratio was observed when precipitation

with a barometric pressure decrease was compared to barometric pressure decrease alone. A decrease in ratio also occurred when cases with both precipitation and barometric pressure decrease were compared to the ratio found in precipitation alone. No cases were observed with "trace of rain" with barometric pressure decrease.

Barometric pressure decrease greater than or equal to .140 (1.40). An increased ratio was observed from barometric pressure decrease alone to barometric pressure decrease with "trace of rain" (2.0). All other precipitation types associated with barometric pressure decrease showed a decreased ratio when compared to barometric pressure decrease alone. When the ratio of the combination of barometric pressure decrease and precipitation types were compared to ratios of precipitation alone, all cases showed a decline in ratio with the exception of "measurable rain" with barometric pressure decrease (1.0) which showed a slight increase from the ratio found in rain alone (0.714).

Barometric pressure decrease greater than or equal to .120 (1.381). An increase in the ratio was present only when "trace of rain" was combined with barometric pressure decrease (2.0) as compared to the ratio occurring with the barometric pressure decrease alone. However, this case showed no increase in ratio when compared to precipitation type alone (2.0). A slight increase in ratio occurred from the ratio of precipitation type (0.714) alone to that ratio occurring when barometric pressure decrease and measurable rain were combined (1.0).

Barometric pressure decrease greater than or equal to .100 (1.381). A substantial increase in the ratio of actual to expected births were noted from barometric pressure decrease alone to "trace of rain" (3.0) and "measurable rain" (4.0) in combination with barometric pressure decrease. All other precipitation types when combined with the barometric pressure decrease showed a decreased ratio. These ratios also increased when "trace" and "measurable amounts of rain" were combined with barometric pressure decrease, as compared with precipitation alone (2.0, 0.714).

Barometric pressure decrease greater than or equal to .080 (1.212), .060 (1.0), .040 (1.0), and .020 (1.039). The ratios increased in the same cases as did those in the previously discussed barometric pressure decrease category with the exception of "trace of rain" with barometric pressure decrease (2.25) compared to "trace of rain" alone (2.0). In this case, there is little change observed in the ratio.

Summary

One of the major problems inherent in this study was the comparison made between the actual and expected number of births occurring during the designated time. As individual charts of patients delivering at USAF Hospital Hill are not available after one year from their filing, it was not possible to know when the expectant mother delivered in relation to her expected date of delivery. It is also possible that those for whom estimated dates of confinement were noted were not necessarily those women who actually delivered.

Also, some women included in the estimated date of confinement calculations left the area. Statistical correction was made in the number of those expected to deliver in order to make a more accurate comparison. Some relationship between the actual and expected number of births is obvious as usually the time period during which more births are expected also contained the greatest number of actual births. Although the use of the expected dates may be a disputed point, its use was also an advantage as a more accurate comparison could be made across the categories.

Lunar Phase. The new moon recorded a larger actual to expected ratio than did the full moon lunar phase.

Barometric pressure decrease. The new moon showed the highest ratio when the barometric pressure decrease was greater than or equal to .160. The full moon showed the largest ratio in actual to expected births after a barometric pressure decrease greater than or equal to .140.

Precipitation. In the new moon lunar phase, the highest ratios were found in "trace of rain" (1.833), "measurable snow" (2.0), and "trace of snow with measurable rain" (3.5). The highest ratio in the full moon lunar phase was found in "trace of rain" (2.0). All other ratios remained essentially the same or decreased.

Conclusion

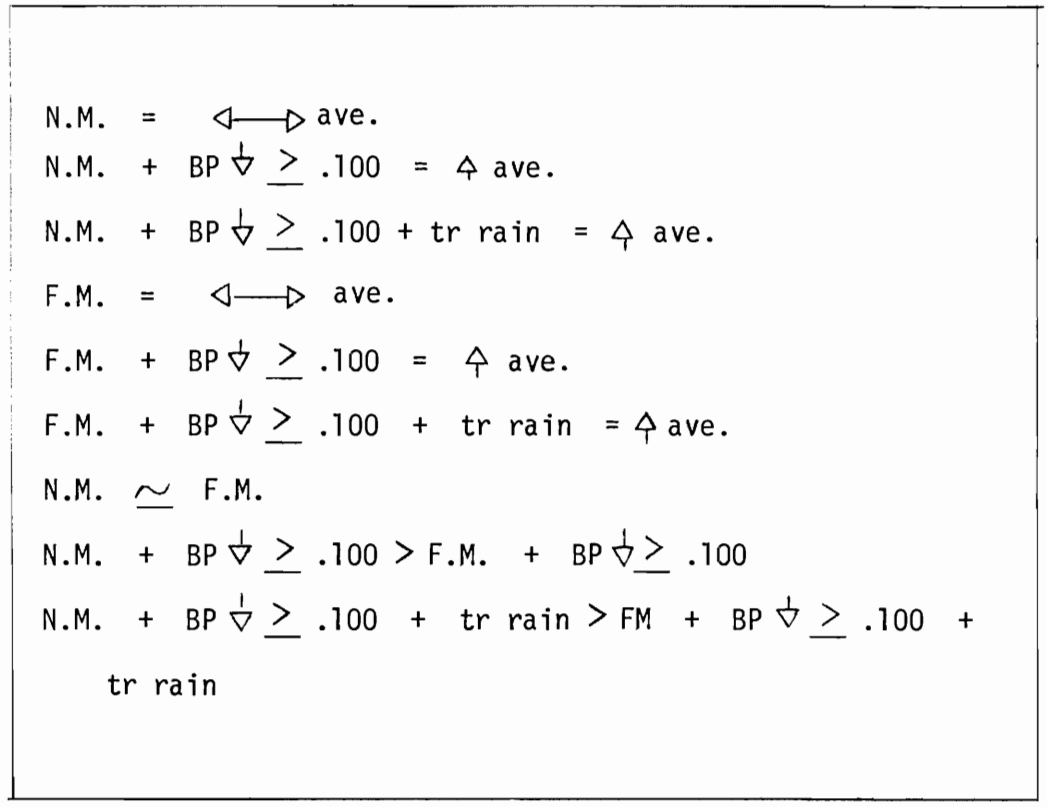
New Moon. The new moon showed a higher ratio of actual to expected births than the ratio expected if the lunar phase was not considered as a variable. All barometric pressure decreases in-

fluenced the birth ratio to become greater than the average ratio. All types of precipitation also showed a higher ratio of births. An even higher ratio of births is found when a barometric pressure decrease is combined with all precipitation types except a "trace of snow." The amount of barometric pressure decrease that most closely related to the higher birth ratio is the barometric pressure decrease greater than or equal to .080.

Full Moon. The ratio of actual to expected births became slightly lower than it would be without lunar phase considered. A barometric pressure decrease of greater than or equal to .080 is necessary before this ratio begins to rise. Precipitation types that influenced the birth ratio to become higher when considered apart from barometric pressure decreases were "trace of rain," "measurable rain" and "measurable snow." An even higher birth ratio was observed when these precipitation types were combined with a barometric pressure decrease. The barometric pressure decrease associated most closely with this higher birth ratio when precipitation was a factor was that of a decrease greater than or equal to .060.

Summary

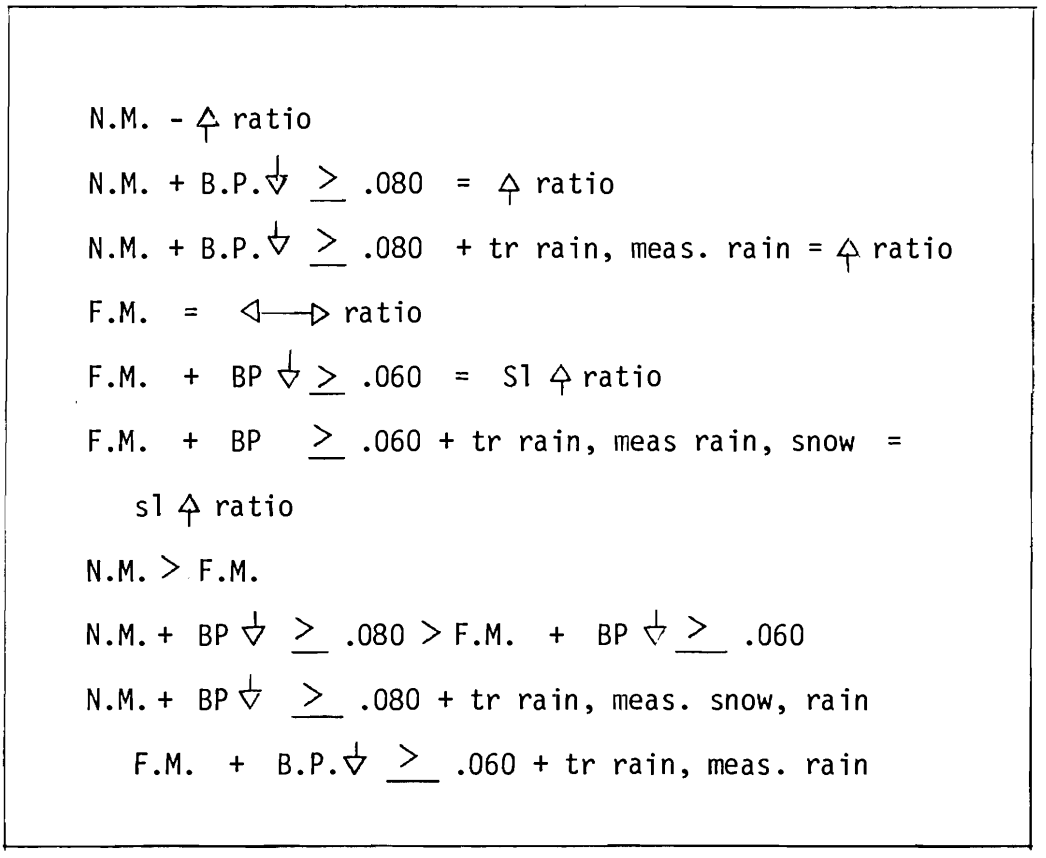
A summary of the findings is reflected in Figures 4 and 5. When barometric pressure decrease was considered jointly with precipitation, the ratio of births in the new moon lunar phase showed a more dramatic rise than during the full moon. The threshold in barometric pressure decrease for a higher birth ratio differs slightly in that a higher ratio of actual to expected births is observed when the



Key: N.M. = new moon; F.M. = full moon; ↑ = increase; ↓ = decrease

⟷ = unchanged

Figure 4. Simplified Findings: Average Births Per Day



Key: N.M. = new moon; F.M. = full moon; ↑ = increase; ↓ = decrease
⟷ = unchanged

Figure 5. Simplified Findings: Actual to Expected Births

barometric pressure decrease is greater than or equal to .060 in the full moon and greater than or equal to .080 during the new moon. Precipitation types most closely allied with a higher ratio include "trace of rain" and "measurable snow."

Thus, the variables of barometric pressure decrease and precipitation appear to play a larger role during the new moon lunar phase than during the full moon phase. When "trace of rain" occurred the prevailing atmospheric charge was positive. Therefore, under influences of positive atmospheric ionization and a barometric pressure decrease, the new moon lunar phase showed a higher birth incidence than the new moon. This was shown both when average births per day and the actual to expected ratios were compared.

Part II: Actual to Expected Births Per Lunar Phase Period

In this section, inferential statistical methods were used. Only actual to expected births were used for comparison. Barometric pressure categories other than barometric pressure decreases were considered alone and in conjunction with the other variables of lunar phases and precipitation.

Lunar Phase

Eight hundred and sixty-two births occurred during the data collection period. The total births in each lunar phase should be one-fourth of that, approximately 215.5, if there were no lunar effect. Since only three of seven days in each lunar phase were used for tabulation, approximately 92.4 births should have occurred during these three days in each lunar phase. However, during the new moon lunar

phase, a total of 122 births occurred or 132% of the expected. A total of 133 births occurred during the full moon phase, 144% of the expected. Although it was postulated that the full moon would have a greater effect on birth incidence than the new moon, these data support the idea that the influences on births of these two opposite lunar phases are approximately equal.

When actual births were compared to standardized expected births occurring during the designated new and full moon days, a minimal difference in the number of births was found. There were 150 expected births during the full moon lunar phase and 125 during the new moon lunar phase. Statistically, no more births in one phase occurred when the ratio of actual to expected births was compared between the two phases. This impression was corroborated by Chi Square.

It is apparent from inspecting the graphs of births by lunar phase and the ratio of expected births by lunar phase that no trend exists although isolated months do show a much larger percentage of births than others. No seasonal or monthly trend is apparent from examination of the plots of the actual, expected or the ratio of actual to standardized expected births (See Appendix B).

Barometric Pressure

The difference between actual and expected births did not vary significantly. Only one category existed in which actual births exceeded standardized expected births. This occurred with the category of barometric pressure decrease. However, through Chi Square

analysis, it was shown that across categories of barometric pressure, there were no significant differences between actual and expected births. Thus, barometric pressure change alone appeared to have no demonstrable influences on labor incidence.

Precipitation

The differences between actual and expected births were compared with the categories of precipitation. Births occurring during the same day of the precipitation occurrence showed a p value less than than .005 but births occurring the day after the precipitation showed p value greater than .05. Those categories showing ratios of actual to expected births in excess of 100% were categories one (trace of rain), four (measurable snow), and six (trace of snow with measurable rain). Category six showed the largest percentage of actual to expected births; however, only three new moon days and no full moon days occurred with these types of precipitation. The greatest influence on birth incidence was found when categories one, four, and six were combined with a p value of less than .005; however, category six made the greatest contribution to this outcome. It was determined that a higher number of births occurred when under the influence of the precipitation occurring the same day of the births.

Positive atmospheric ionization was present during "trace of rain" and "measurable amounts of snow." Although measurable rain was included in precipitation type six, the finding was not dependable as so few days were represented. This finding supports the idea that positive ionization as indicated by precipitation types "trace

or rain" or "measurable snow" are associated with higher numbers of births.

Barometric Pressure/Lunar Phase

The differences between actual and standardized expected births across all categories of barometric pressure change and between new and full moon lunar phases were not statistically significant ($p = .5$). Thus, the joint effects of lunar phase and barometric pressure change were unimportant. However, actual births exceeded standardized expected births by the largest margin under the condition of barometric pressure decrease in both lunar phases. As seen in Table 4, the new moon had the larger ratio (148% - 125%). This supports this hypothesis that large barometric pressure decreases positively influence labor. Yet the influence is most pronounced during the new moon, contrary to expectations. In any event, the influence seems apparent.

The weak support for the idea of a conjoint positive influence on labor of the full moon lunar phase and barometric pressure decrease are possibly due to the absence of large barometric pressure decreases during the full moon. However, the barometric pressure decrease periods occurred four times during the full moon and five times during the new moon, not a large difference in frequency of occurrence. Thus the finding reported previously must stand.

All barometric pressure categories also differenced in number of periods included by only one, with the exception of stable barometric pressure. Stable periods occurred during 12 full moon periods

Table 4

Actual to Expected Births: Barometric Pressure and Lunar Phase

Barometric Pressure Category	Lunar Phase	
	New Moon	Full Moon
1	148%	125%
2	108%	86%
3	93%	99%
4	76%	82%
5	114%	87%

compared to only eight new moon periods (Appendix C). In light of the fact that the relevant literature indicates that less stable weather occurs during the full moon lunar phase, this was a surprising finding. According to the graph comparing actual births occurring during the new and full moon lunar phases, it appears initially that births occur more frequently during stable barometric pressure and during the full moon lunar period. However, it must be recognized that there were more stable days during the full moon lunar phases than during the new moon phases. This would result in a greater number of births occurring during this phase within the stable barometric pressure category.

Precipitation/Lunar Phase

Comparison between lunar phases and the number of days ocurring in each phase compared with each type of precipitation was made. Only precipitation types 0 and 2, "absence of precipitation" and "trace of snow" roughly equalled one another. During the two lunar phases, 59 days of no precipitation occurred during the new moon and 56 during the full moon. When "trace of snow" occurred, 9 such days were included in both lunar phases. More days with "trace of rain" or "measurable snow" occurred during the full moon phase. Seventeen days with "trace of rain" occurred during the full moon compared to only seven days found in the new moon. Eight days of "measurable rain" occurred during the full moon and only four during the new moon. "Measurable rain" occurred more frequently during the new moon as 18 such days were included in this phase compared with

10 during the full moon phase (Appendix C). All days (3) of "trace of snow" combined with "measurable rain" occurred during the new moon lunar phase.

Data regarding actual and expected births were organized according to the percentages of actual to standardized expected births that occurred during each type of precipitation and each lunar phase. Table 5 reflects this arrangement.

The highlighted sections of the table refer to percentages of actual to expected births that exceeded 100%. It is readily seen that the majority of percentages greater than 100% occurred during the new moon lunar phase. These occurred during all precipitation categories with the exception of "trace of rain." The only sizable ratio found occurring during the full moon was that of "measurable rain." The lowest ratio in both lunar phases occurred in the precipitation category "trace of rain."

No definite correlation between atmospheric ionization and a higher number of births could be discerned. Positive ionization in the form of "trace of rain" showed the smallest ratio. The "measurable rain" category was only slightly higher than 100%. In this case, negative or neutral ionization, particularly during the new moon lunar phase, had a greater influence on birth incidence.

Barometric Pressure/Precipitation

Barometric pressure categories were crossindexed with precipitation types. These results are shown in Table 6. By referring to Table 6, the highest percentages of births occurred when "trace

Table 5

Percentage of Actual to Expected Births Occurring During Precipitation Types and Lunar Phase

Precipitation	Lunar Phase	
	New Moon	Full Moon
Ø	186.6%	94.8%
1	44.3%	72.5%
2	176.7%	85.2%
3	116.8%	197.8%
4	112.2%	106.5%
6	144.3%	Ø

Note. Highlighted values exceeded 100%.

Table 6

Barometric Pressure Categories Crossindexed with Precipitation Types

Barometric Pressure Category	Precipitation					
	Ø	1	2	3	4	6
1	156%	109%	284%	103%	103%	258%
2	113%	Ø	284%	43%	120%	Ø
3	88%	183%	17%	426%	103%	Ø
4	54%	Ø	Ø	146%	69%	103%
5	292%	Ø	71%	69%	152%	Ø

of snow" was combined with "measurable rain" during a barometric pressure decrease, "trace of snow" during a barometric pressure increase, "trace of rain" during barometric pressure stability, "measurable rain" when the barometric pressure decreased, and subsequently increased, and in the absence of precipitation during barometric pressure increase followed by a decrease. Higher percentages also occurred during "trace of snow" with barometric pressure decrease and "measurable snow" during a barometric pressure increase.

Table 7 was developed in order to clarify the relationships found between barometric pressure categories and atmospheric ionization. During all times of negative atmospheric ionization, a higher percentage was found when compared to times of positive or neutral ionization except during barometric pressure category five, an increase followed by a decrease, in which the percentage was largest during times of neutral ionization. However, if percentages of all types of precipitation are compared to percentages occurring during no precipitation, it can be seen that precipitation during all barometric pressure categories will have impact on the birth rate.

Lunar Phase/Barometric Pressure/ Precipitation

The data were organized into the number of births occurring during the new and full moon lunar phases by categories of both barometric pressure and precipitation. Expected and standardized expected births were organized in the same way. When the ratio of actual to standardized expected births was calculated, any

Table 7

Relationship Between Barometric Pressure Categories and Atmospheric Ionization

Barometric Pressure Category	Precipitation		
	Positive	Negative	Neutral
1	212%	387%	156%
2	120%	327%	113%
3	286%	443%	88%
4	69%	146%	54%
5	152%	140%	292%

standardized expected value equalling zero was changed to 0.5 (a continuity correction recommended by the biostatistician, Dr. Marlene Egger). Chi square for this section was calculated with a p value less than .01, a significant finding.

In order to visualize the comparison among lunar phases, barometric pressure categories and precipitation types, Table 8 is provided. Shown are comparable categories where important differences in birth ratios exist.

Those cells containing the largest percentages were located predominantly in the new moon lunar phase. When ratios between the new and full moon lunar phases were compared, those cells containing approximately double the birth rate of the same cells in the other lunar phase were noted. Six cells in the new moon lunar phase exceeded the full moon values by that amount or more. Only two cells in the full moon lunar phase exceeded the comparable cells in the new moon lunar phase. Additionally, four cells in the new moon lunar phase showed no actual or expected births during the full moon. Three cells in the full moon showed no actual or expected births in the opposite lunar phase. Cells without births in the other lunar phase included those in the new moon lunar phase with "measurable amount of snow" and a decrease in barometric pressure, "measurable amount of rain" and a decrease in barometric pressure, "measurable amount of rain" with "trace of snow" and a decrease in barometric pressure, and "measurable amount of rain with trace of snow" and barometric pressure decrease followed by an increase. Cells without percentages found in the opposite lunar phase in the full moon

Table 8

Relationship among Barometric Pressure Categories, Lunar Phases and Precipitation Types

Barometric Pressure Categories	Lunar Phase	Percentages of Actual to Expected Births: Precipitation					
		Ø	1	2	3	4	6
1	New		144%	412%		206%	515%
	Full		74%	155%		Ø	Ø
2	New			412%		155%	
	Full			155%		86%	
3	New		77%	Ø	52%	Ø	
	Full		289%	34%	800%	206%	
4	New				241%	Ø	206%
	Full				52%	137%	Ø
5	New	51.5%			137%	200%	
	Full	69%			Ø	103%	

included stable barometric pressure with "measurable amount of snow," and a decrease followed by an increase in barometric pressure with "measurable amount of snow."

Table 9 illustrates trends in birth incidence which show the lunar phase that appears to most influence birth incidence during particular types of precipitation and categories of barometric pressure. It should be noted that birth incidence favoring the new moon occurred during barometric pressure categories 1, 2 and 6. The only barometric pressure category in which the full moon was favored was category 3, stable barometric pressure. Both lunar phases were represented in barometric category 5.

During the stable barometric pressure, precipitation was associated with larger birth ratios during the full moon lunar phase. Barometric pressure does not appear to play a role in determining birth incidence in this category.

In category 1, a decrease in barometric pressure, the larger ratio of births occurred during the new moon lunar phase when a barometric pressure decrease was combined with all types of precipitation except "measurable rain." A greater ratio of births occurred during times of snow and the new moon lunar phase when an increase in barometric pressure was present. Precipitation linked with larger birth ratios in category 4, a decrease followed by an increase in barometric pressure, included all "measurable amounts of rain or snow", "measurable rain" in the new moon and "measurable snow" during the full moon lunar phase.

When an increase was followed by a decrease in barometric

Table 9

Trends in Birth Incidence

Precipitation Types	Barometric Pressure				
	1	2	3	4	5
ø					0
Trace rain	X		(0)		
Trace snow	X	X	(0)		
Measurable rain			0	X	X
Measurable snow	(X)	X	(0)	(X)	
Trace snow, measurable rain	(X)			(X)	

Note. X = new moon; 0 = full moon, ( ) = no cases in opposite lunar phase.

pressure in category 5, only the new moon lunar phase showed any effect on birth incidence. This occurred with no precipitation and with "measurable amounts of rain or snow."

Summary

In neither analysis did lunar phase alone appear to be a contributing factor in birth incidence. In the first section of data analysis, it was seen that barometric pressure decreases of a particular amount were prerequisite to a higher number of births. Barometric pressure decrease was defined differently in the second section. Differing results might have been evidenced had a dividing point other than .160 been utilized for the second section. In general, both methods of analysis supported the premise that barometric pressure changes and precipitation play a larger role in determination of birth incidence during the new moon lunar phase.

CHAPTER V

DISCUSSION AND RECOMMENDATIONS FOR FURTHER RESEARCH

The theory discussed in Chapter II asserted that meteorological conditions that would positively influence the birth rate would be those of a full moon lunar phase, barometric pressure decrease, and positive atmospheric ionization. Conditions under which the birth rate would be unaffected were those of a new moon lunar phase in conjunction with barometric pressure stability and neutral or negative atmospheric ionization.

The findings supported these expectations and provided other information about the interrelationships among the key variables. It was discovered that the resulting incidence of births changed depending upon how the variables were viewed and in what combinations they occurred.

Lunar phase alone did not appear to effect birth incidence in any obvious way. Barometric pressure decrease in both lunar phases did result in a higher than expected incidence of births. Positive ionization as indexed by "trace of rain" and "measurable snow" combined with the lunar phase resulted in lower percentages of births in the new moon and in an unchanged percentage in the full moon lunar phase. However, an increase in the percentage of births

occurred when both negative and neutral ionization were combined in the new moon lunar phase. Under these same circumstances, but in the full moon lunar phase, no change in the percentage of actual to expected births was noted.

A higher incidence of births did occur during the full moon, barometric pressure decrease and with positive ionization. However, a higher number also occurred during the new moon lunar phase under these same conditions. This suggests the conclusion that barometric pressure decrease and positive ionization may be linked with higher number of births rather than lunar phase. Under conditions of the new moon, stable barometric pressure, and negative ionization, the percentage of actual to expected births dropped. When neutral ionization was added to the new moon and stable barometric pressure conditions, the percentage of births remained essentially as expected.

Discussion of Theory

The findings support the theory in large measure. However, it should be further elaborated as the relationships among the variables are far more complex than first realized. Table 10 illustrates the complicated nature inherent in the development of this theory.

The literature suggests that precipitation is more common during the full moon lunar phase. The presence of precipitation will usually mandate the coexistence of a barometric pressure decrease. Under these conditions, it was postulated that the incidence of births would increase. The converse of this hypothesis is that births are

Table 10

Continued Theory Development

Lunar Phase	Barometric Pressure	Precipitation	Frequency of Occurrence	Idiosyncratic Event	Birth Incidence Expectation
New Moon	Increase	Present (+)	Rarely	Precipitation (+)	Increase
		Absent (-)	Common		No Change
	Stable	Present (+)	Rarely	Precipitation (+)	No Change
		Absent (-)	Common		No Change
	Decrease	Present (+)	Rarely	Lunar Phase	Increase
		Absent (-)	Rarely	Barometric Pressure Decrease	Increase
Full Moon	Increase	Present (+)	Rarely	Barometric Pressure Increase	Decrease
		Absent (-)	Rarely	Lunar Phase	Decrease
	Stable	Present (+)	Rarely	Barometric Pressure Stable	Increase
		Absent (-)	Rarely	Lunar Phase	Decrease
	Decrease	Present (+)	Common		No Change
		Absent (-)	Rarely	Precipitation (-)	No Change

less likely to occur during the new moon lunar phase when precipitation is absent and the barometric pressure is stable or perhaps increasing.

A different situation from this norm is present during the full moon when barometric pressure stability or an increase occurs. The situation also differs when precipitation does not occur during this lunar phase. The birth incidence could be expected to decrease in these situations.

The human organism would be expected to respond to these changes from the usual to the unusual in particular ways. It is postulated that a deviation from the usual events occurring in either the new or full moon lunar phases would also result in a change in the birth incidence. If, however, the unusual occurrence were overridden by a stronger or more important occurrence to birth incidence, the number of births would be influenced by this as well.

If one or more events that do not usually occur during the new moon do in fact occur, an increase in birth incidence should be observed. Those events would be a decrease in barometric pressure and/or the presence of precipitation.

During the full moon, the absence of precipitation or the presence of a barometric pressure increase or barometric pressure decrease of stable character are not expected to occur. If these do occur, the birth incidence could then be expected to decrease. An increase in birth incidence would occur only if the lunar phase was the most important influence. If all factors expected were present including the full moon lunar phase, a decrease in barometric pressure, and

the presence of precipitation, the birth incidence could be expected to remain as expected rather than increasing.

This response may largely depend upon the adaptation of the human body to the expected weather conditions as they have occurred over time. The body may, in fact, expect a barometric pressure decrease and precipitation to occur during the full moon lunar phase. In this case, the effect of these conditions may be limited due to this habituation response. To override this response, a more severe decrease in barometric pressure and a particular type or amount of precipitation may be necessary in order for the birth incidence to become greater.

The body may respond differently, however, to changes not expected during the new moon lunar phase. Since a barometric pressure decrease or presence of precipitation is not expected during the new moon, the body could react, the result being an increase in the incidence of births.

The theory was partially substantiated. An exception in the new moon lunar phase was found with the condition of stable barometric pressure coexistent with the presence of precipitation as here a smaller number of births were found contrary to the expectation that no change in birth incidence would occur. Two exceptions were also found in the full moon lunar phase. During times of barometric pressure increase and no precipitation, it was thought that a smaller birth incidence would occur; however, the birth incidence remained unchanged. It was also postulated that during a barometric pressure decrease and precipitation that no change in birth incidence

would occur, when, in fact, more births were observed.

Recommendations for Future Research

Certainly, further testing of this theory is indicated to substantiate its validity. The theory should be expanded by evaluation of the types and amounts of precipitation necessary to initiate labor. It would also be advantageous to repeat the research in differing geographical locations to determine whether variations are found in birth incidence with differing barometric pressure categories and precipitation types, depending on geographical location in which the study is completed. In conjunction with these types of investigations, a better correlation of atmospheric ionization to precipitation types should be attempted. Other meteorological conditions such as the presence of warm or cold air fronts and their relationship to birth incidence should also be examined. This would be helpful in the identification of particular days during which a lunar effect might be present. In addition, variations and trends in barometric pressure over time would be more easily discernible and thus, the effect of barometric pressure more readily measured.

An investigation correlating gestational age assessment after birth with approximate time of conception would be valuable in determining whether more conceptions occur during a particular lunar phase, thus leading to an increase in the number of births, both actual and expected during the same lunar phase as the conception. This phenomenon could account for more births than expected actually occurring during a particular lunar phase.

In order to improve the validity on which these conclusions are based, it would be helpful if the researchers could determine whether the population of both actual and expected births were the same by identifying those delivering in relation to their estimated dates of confinement.

Significance to Nursing

Staffing cannot be founded on meteorological conditions at present although a basis for predicting an increase in the birth rate is possible as evidenced in the results of this investigation. However, as future studies are completed, it is believed that staffing of Obstetrical Units can be planned according to meteorological conditions.

APPENDIX A

SAMPLE DATA RECORD: LUNAR

PHASE 7

Military Time	Dates				
	28 Nov.	29 Nov.	30 Nov. (0-119)[a]	31 Dec.	
1	H 25.340	25.215 5	25.170 13 b	H 24.930 21	29
4	.300	.195 6	.195 14	L .860 22	30
7	.310	.215 7	.225 15	.915 23	31
10	.280 (1049)	H .235 8 (1035)	H .250 16 (one)	.925 24	32
13	.255 1	.225 9	.175 17	.915 25	33
16	L .235 2	.225 10	.150 18	.915 26	
19	.240 3	.220 11	.090 19	.925 27	
22	.240 4	L .205 12	L .010 20	.910 28	
Time of Births	1049	1035(A)	Time Unknown(A)	0510	Ø
Barometric Pressure Change	▽.105	▽.030	▽.240	▽.070	
Type of Precip	2 Tr Snow	4 Meas. Snow	4 Meas. Snow	3 Meas. Rain	
Number of Births Expected	1	1	Ø	1	1

[a]Refers to expected lunar change
[b]Refers to actual lunar change

APPENDIX B

BAROMETRIC PRESSURE TRENDS

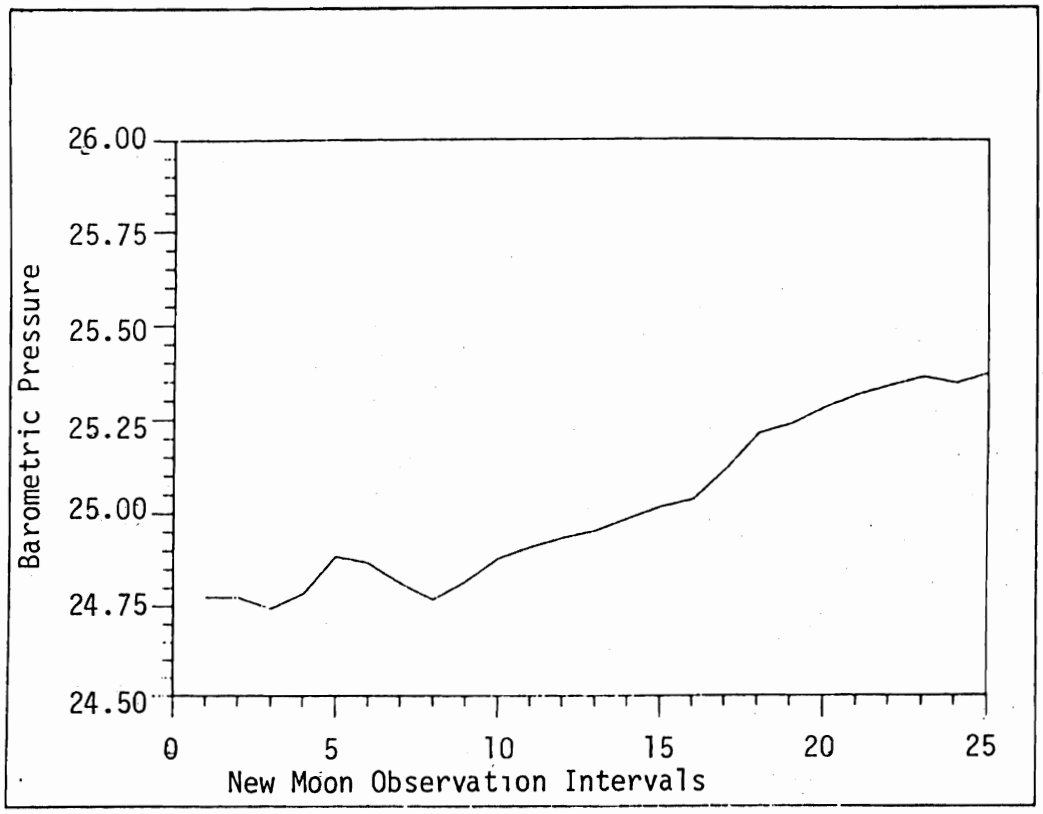


Figure 6. Barometric Pressure Trends: Tendency, Rising

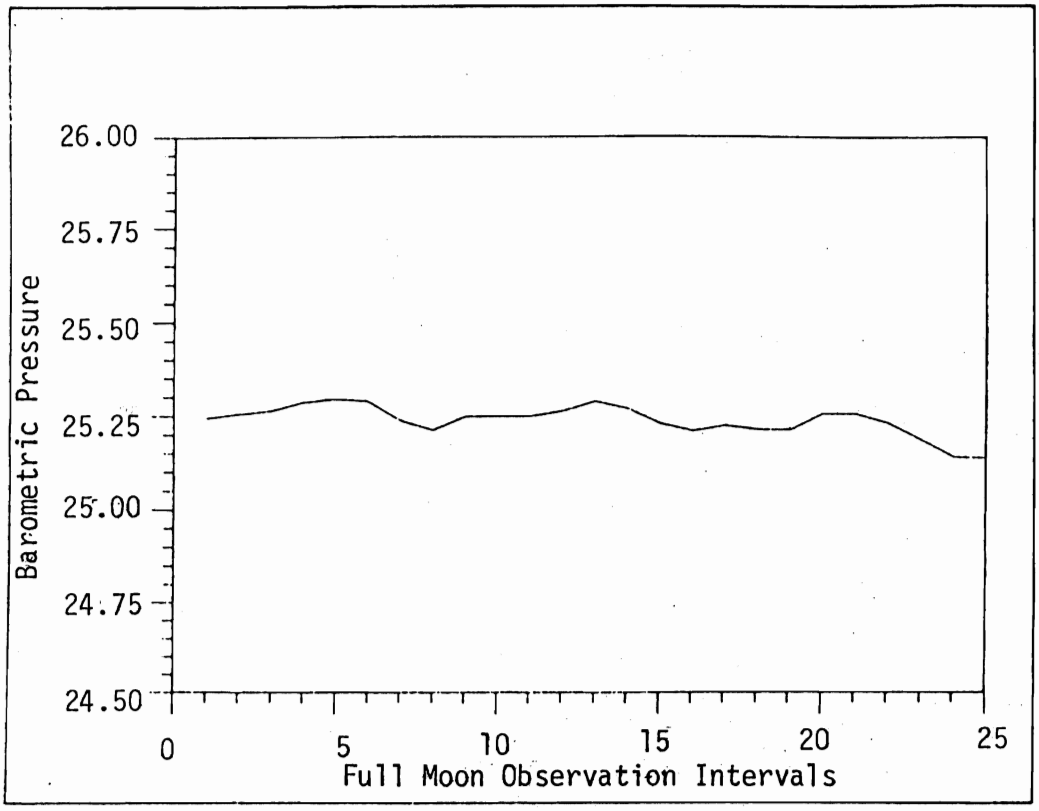


Figure 7. Barometric Pressure Trends: Tendency, Stable

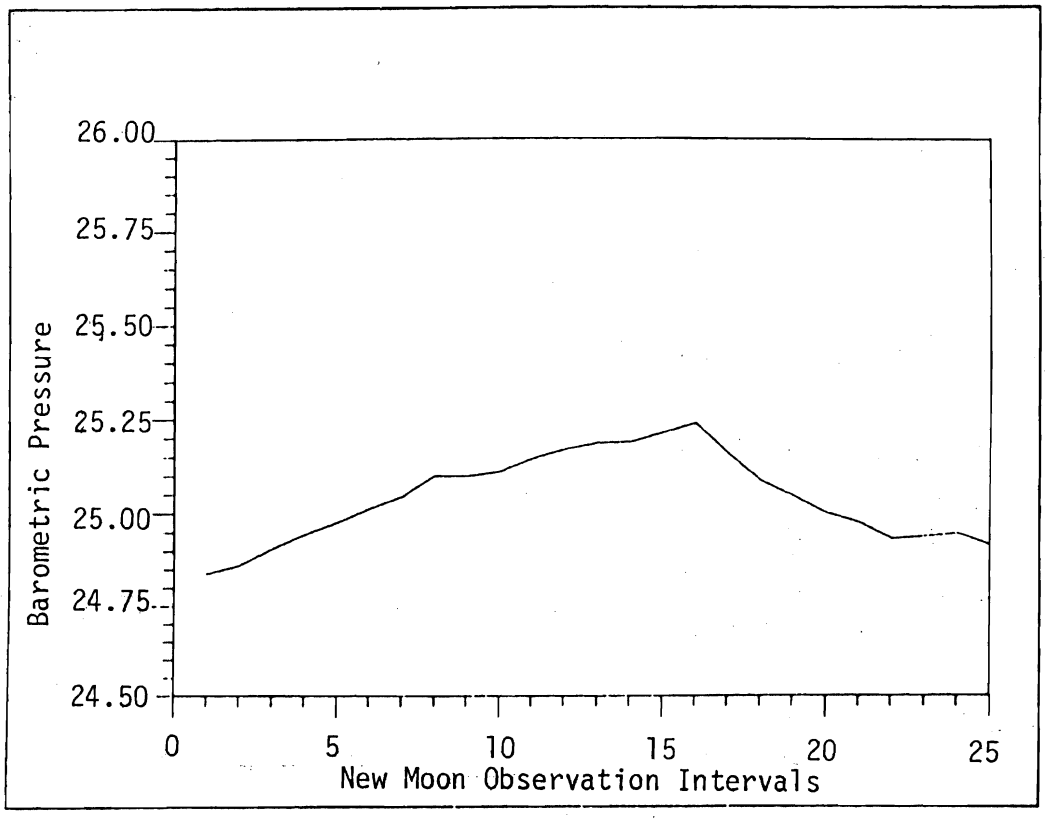


Figure 8. Barometric Pressure Trends: Tendency, Rising/Falling

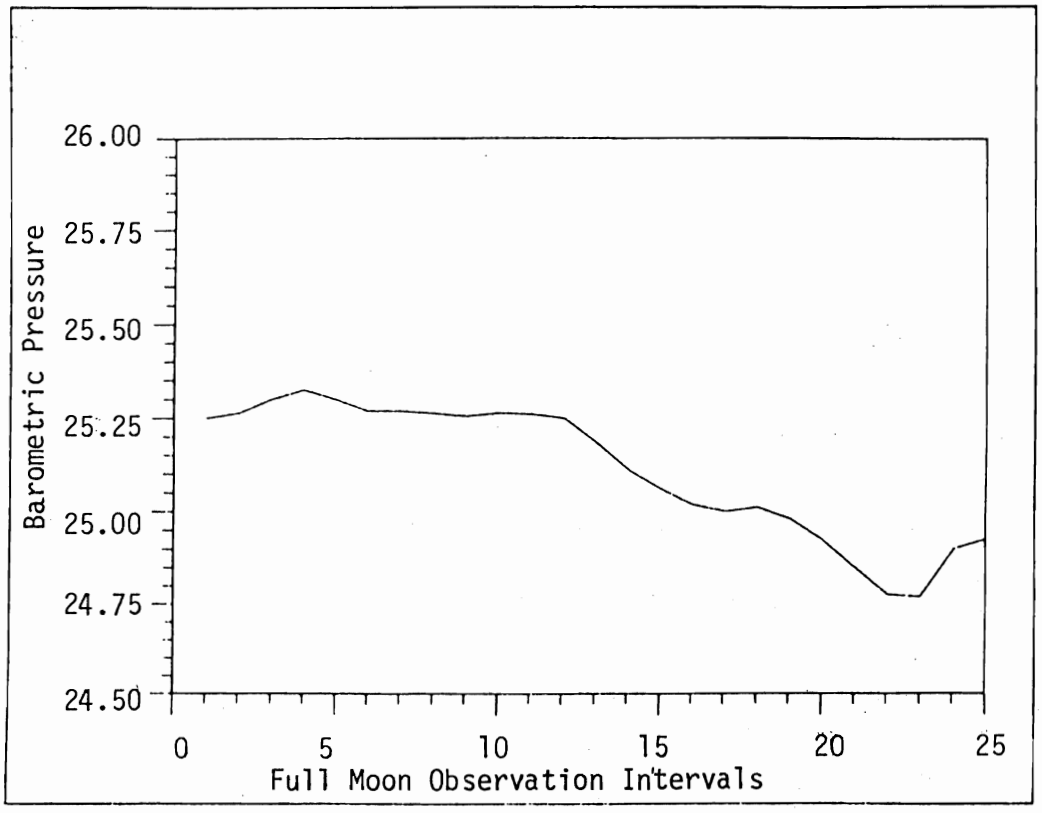


Figure 9. Barometric Pressure Trends: Tendency, Falling

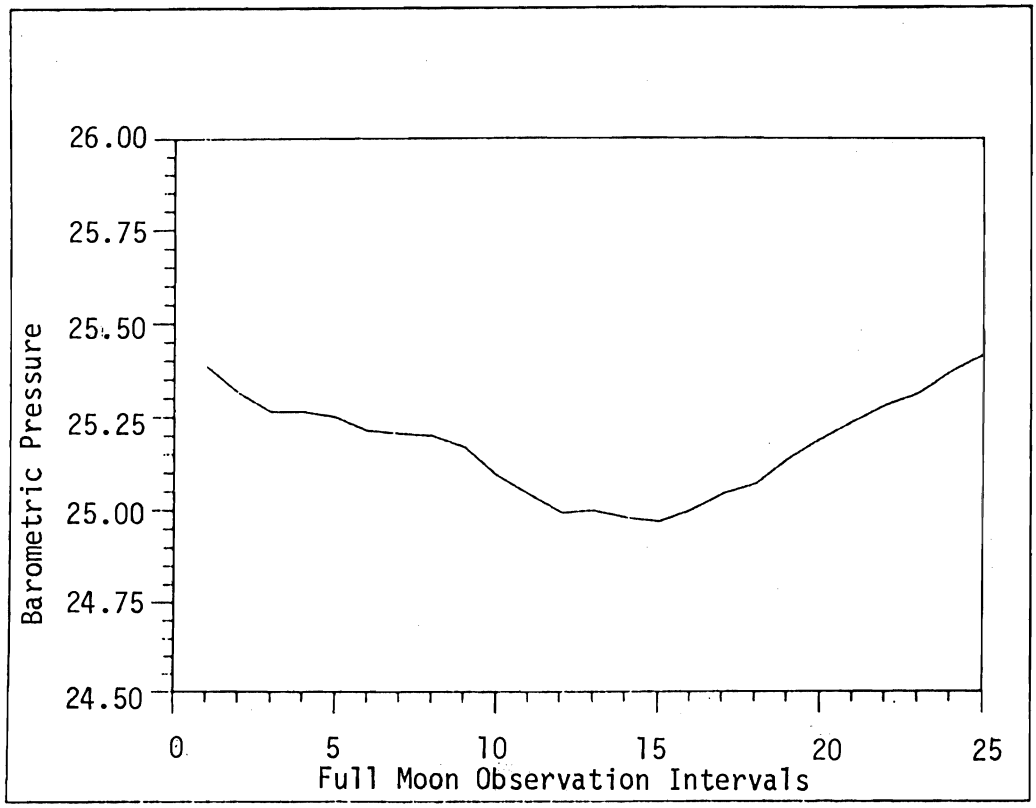


Figure 10. Barometric Pressure Trends: Tendency, Falling/Rising

APPENDIX C

TABLES SUMMARIZING DATA

Table 11

The Births Per Barometric Pressure Category

Births	Categories				
	1	2	3	4	5
Actual Births	52	41	92	38	32
Percent of Total Births	20.4%	16.1%	36.1%	14.9%	12.5%
Expected Births	41	46	103	52	34
Standar-dized Expected Births	47.88	42.5	95.163	48.043	31.413
Percent of Total Expected Births	14.9%	16.7%	37.3%	18.8%	12.3%
Ratio Actual/ Expected	1.373	0.965	0.967	0.791	1.019

Table 12

Categories of Precipitation Compared: Day on Which Precipitation Occurred

Variables	Precipitation						
	0	1	2	3	4	6	Total
Actual Births	112	29	25	31	22	7	226
Expected Births	132	22	28	32	17	2	233
Std. Expected	128.04	21.34	27.16	31.04	16.49	1.94	226.01
Perc (Act/Exp)	0.8747	1.3590	0.9205	0.9987	1.3341	3.6082	
Ave. Act. Per Day	0.9739	1.2083	1.3889	1.1071	1.8333	2.3333	1.1300
Ave. Exp. Per Day	1.1134	0.8892	1.5089	1.1086	1.3742	0.6467	1.1301
No. of days	115	24	18	28	12	3	200
Chi-X Test	2.01	2.75	0.15	0.00	1.84	13.20	19.95

Standardizing Factor = Total Actual (226)/Total Expected = 0.9700

$p < .005$

Table 13

Categories of Precipitation Compared: Day After Precipitation Occurred

Variables	Precipitation						
	0	1	2	3	4	6	Total
Actual Births	107	31	22	31	18	3	212
Expected Births	114	20	28	33	16	4	215
Std. Expected	112.4040	19.7200	27.6080	32.5380	15.7760	3.9440	211.9900
Perc (Act/Exp)	0.9519	1.5720	0.7969	9.9527	1.1410	0.7606	
Ave. Act. Per Day	0.9304	1.2917	1.2222	1.1071	1.5000	1.0000	1.0600
Ave. Exp. Per Day	0.9774	0.8217	1.5338	1.1621	1.3147	1.3147	1.0599
No. of Days	115	24	18	28	12	3	200
Chi-X Test	0.26	6.45	1.14	0.07	0.31	0.23	8.46

Standardizing Factor = Total Actual (212)/Total Expected(215) = 0.9860

$p < .05$

Table 14

New Moon Actual/Expected Ratio

BP Change	Precipitation						
	0	1	2	3	4	6	Ave
1	164.955765	144.336288	412.389374	103.097343	206.194687	515.786694	257.743378
2	103.097359	0.000000	412.389374	51.548672	154.646027	0.000000	120.280243
3	103.097343	77.323013	0.000000	51.548672	0.000000	0.000000	38.661507
4	46.393806	0.000000	0.000000	240.560486	0.000000	206.194687	82.191498
5	515.486694	0.000000	58.912766	137.463135	200.000000	0.000000	151.977097
Ave	186.606201	44.331860	176.738312	116.843666	112.168152	144.336273	

Table 15

Full Moon Actual/Expected Ratio

BP Change	Precipitation						
	0	1	2	3	4	6	Ave
1	147.281921	73.640961	154.646027	103.097343	0.000000	0.000000	79.7777
2	123.716820	0.000000	154.646027	34.365784	85.914459	0.000000	66.4405
3	72.168144	288.672577	34.365784	800.000000	206.194687	0.000000	233.5670
4	61.858410	0.000000	0.000000	51.548679	137.463135	0.000000	41.1167
5	68.731567	0.000000	82.477882	0.000000	103.097359	0.000000	42.3845
Ave	94.751373	72.462708	85.227142	197.802368	106.533936	0.000000	

Table 16

Ratio Actual/Standard/Expected Births

BP Change	Precipitation												
	New Moon						Full Moon						
	0	1	2	3	4	6	0	1	2	3	4	6	Ave
1	164.956	144.336	412.389	103.097	206.195	515.487	147.282	73.641	154.646	103.097	0.000	0.000	168.7605438
2	103.097	0.000	412.389	51.549	154.646	0.000	123.717	0.000	154.646	84.366	85.914	0.000	93.3603821
3	103.097	77.323	0.000	51.549	0.000	0.000	72.168	288.673	34.366	800.000	206.195	0.000	136.1141815
4	46.394	0.000	0.000	240.560	0.000	206.195	61.858	0.000	0.000	51.549	137.463	0.000	62.0016022
5	515.487	0.000	48.913	137.463	200.000	0.000	68.732	0.000	82.478	0.000	103.097	0.000	97.1807861

Table 17

Relationship Between Barometric Pressure and Precipitation

Barometric Pressure	Precipitation						Mean
	0	1	2	3	4	6	
1	156.119	108.9885	283.5175	103.097	103.0975	257.743	168.7605
2	113.407	Ø	283.5175	42.9575	120.28	Ø	93.3603
3	113.407	Ø	17.183	42.5775	42.5775	103.0975	136.1143
4	54.126	Ø	70.6955	68.7375	161.5445	Ø	97.1808
Mean	140.6788	48.3973	130.98	157.323	109.351	72.1682	

Table 18

Actual and Expected Births: Barometric Pressure Category Vs. Lunar Phase

Category	New Moon			Full Moon		
	Actual	Std. Exp.	Percentage Act./Exp.	Actual	Std. Exp.	Percentage Act./Exp.
1	30	20.33	1.48	22	17.55	1.25
2	32	20.33	1.08	19	22.17	0.86
3	31	33.26	0.93	61	61.90	0.99
4	19	24.95	0.76	19	23.10	0.82
5	20	17.55	1.14	12	13.86	0.87
Total	122			133		

Standardizing Factor = Total Actual (New + Full)(255)/Total Expected (New + Full)(276) = 0.92

Table 19

Lunar Phase Periods Per Barometric Pressure Category

	Barometric Category					
	1	2	3	4	5	Total
New Moon Periods	5	5	8	4	3	25
Full Moon Periods	4	4	12	3	2	25

REFERENCES

Arichi, S., & Sakaguchi, M. The relationship between lunar periodicity and human birth rate. In Abstracts of the Sixteenth Annual Meeting of the Japanese Society of Biometeorology, Kusatsu, 24-25 November 1977. International Journal of Biometeorology, 1979, 23(2), 151-176.

Bonsnes, R.W. Composition of amniotic fluid. In F. Fuchs (Ed.). Clinical obstetrics and gynecology. New York: Harper and Row, June 1966, pp. 440-448.

Brezowsky, H. Morbidity and the weather. In S. Licht (Ed.). Medical climatology. Baltimore: Waverly Press, Inc., 1964, pp. 358-399.

Brezowsky, H., & Dietal, H. The effect of weather and season on labor onset, labor duration, premature fetal membranes rupture and premature delivery. Zeitschrift fur Geburtshilf und Perinatilogie, February 1967, 166(3), 244-271.

Burgess, A. The nurse's guide to fluid and electrolyte balance. New York: McGraw-Hill Book Company, 1979.

Clark, A.O., & Affonso, D.D. Childbearing: A nursing perspective. Philadelphia: F.A. Davis Company, 1979.

Coffin, T. P. & Cohen, H. Folklore. New York: Anchor Press, 1973.

Drewes, W. Influences of the moon on childbirth. O Hospital, November 1969, 76(5), 1825-1832 [Translated, Helga Westphal, Portuguese].

Fast, J. Weather language. New York: Wyden Books, 1979.

Ganong, W.F. Review of medical physiology. Los Altos, California: Lange Medical Publications, 1979.

Geller, S.H., & Shannon, H.W. The moon, weather and mental hospital contacts: Confirmation and explanation of the Transylvania effect. JPN and Mental Health Services, January 1976, 13-17.

Gillibrand, P.N. Changes in the electrolytes, urea, and osmolality of the amniotic fluid with advancing pregnancy. Journal of Obstetrics and Gynecology of the British Commonwealth, October 1969, 76, 898-905.

Greenhill, J.P. & Friedman, E.A. Biological principles and modern practice of obstetrics. Philadelphia: W.B. Saunders Company, 1974.

Guyton, A.C. Textbook of medical physiology. Philadelphia: W.B. Saunders Company, 1976.

Hawkins, L.H., & Barker, T. Air ions and human performance. Ergonomics, 1978, 21(4), 273-278.

Hollander, J.P., & Yeostros, S.Y. The effect of simultaneous variations of humidity and barometric pressure on arthritis. AJBS Bulletin, 1963, 13, 24-28.

Hytten, F.E., & Lind, T. Diagnostic indices in pregnancy. Basle, Switzerland: CIBA-GEIGY Limited, 1973.

Jacobs, F. Untersuchengen uber den Einfluss atmospharischer Vorgange auf Wahentatigkeit, Geburtenfrenquenz und Eklampsievolkommen. Deutsche Medizinische Wochenschrift, May 12, 1933, 19, 720-723.

Landsberg, H. Weather and health. Garden City, New York: Doubleday and Company, Inc., 1969.

Licht, S. Medical climatology. Baltimore: Waverly Press, Inc., 1964.

Lind, T., Billewicz, W.Z., & Cheyne, G.A. Composition of the amniotic fluid and maternal blood through pregnancy. Journal of Obstetrics and Gynecology of the British Commonwealth, June 1971, 78, 505-512.

Masterson, M. Relationship of birth incidence to barometric pressure variations and lunar phse. Unpublished manuscript. University of Utah, November 16, 1980.

Menaker, W. Lunar periodicity with reference to live births. American Journal of Obstetrics and Gynecology, August 1, 1967, 98(7), 1002-1004.

Menaker, W., & Menaker, A. Lunar periodicity in human reproduction: A likely unit of biological time. American Journal of Obstetrics and Gynecology, April 1959, 77(4), 905-914.

Milingos, S., Messinis, I., Diakomanolis, D., Arayantionos, D., & Kaskarelis, D. Influence of meteorological factors on premature rupture of fetal membranes. The Lancet, August 19, 1978, 435.

Mills, C.A. Climate makes the man. New York: Harper and Brothers Publishers, 1942.

Ostergard, D.R. The physiology and clinical importance of amniotic fluid: A review. Obstetrical and Gynecological Survey, 1966, 25, 297-319.

Oxorn, H., & Foote, W.R. Human labor and birth, (4th Ed.). New York: Appleton-Century-Crofts, 1980.

Paul, R.H. Management of the threatened premature delivery. In S. Aladjem and A. Brown (Eds.), Perinatal intensive care. Saint Louis: The C.V. Mosby Company, 1977, pp. 208-215.

Pavlik, I. Significance of air ionization. In S. Licht (Ed.), Medical climatology. Baltimore: Waverly Press, Inc., 1964, pp. 317-342.

Peterson, W.F. Man - weather and sun. Springfield: Charles C. Thomas, 1947.

Polit, D., & Hungler, B. Nursing research: Principles and methods. Philadelphia: J.B. Lippincott Company, 1978.

Reeder, S.R., Mastroianni, L., Martin, L.L., & Fitzpatrick, E. Maternity nursing. Philadelphia: J.B. Lippincott Company, 1976.

Reiter, R. Atmospheric electricity and natural radioactivity. In S. Licht (Ed), Medical climatology. Baltimore: Waverly Press, Inc., 1964, pp. 280-316.

Rosen, S. Weathering. New York: M. Evans and Company, 1979.

Schnurman, A.G. Effect of the moon on childbirth. Virginia Medical Monthly, February 1949, 76, 78.

Snorrason, E. Early hisotyr of medical climatology. In S. Licht (Ed.), Medical climatology. Baltimore: Waverly Press, Inc. 1964, pp. 594-612.

Sturrock, E.W., & Yeomans, S. The first stage of labor. In J. Clausen, M.H. Flook, B. Ford, M. Green, & E. Popiel (Eds.), Maternity nursing today. New York: McGraw-Hill Book Company, 1973, pp. 433-485.

Soyka, F. The ion effect. New York: E.P. Dutton and Company, 1977.

Tromp, S.W. The relationsip of weather and climate to health and disease. In G. Howe (Ed.), Environmental medicine. London: Heinemann Medical, 1973, pp. 72-99.

Tugend, T. Lunar cycle does not affect birthrate. UC Clip Sheet, February 19, 1980, 55(27), 1.

Turowski, J., & Pawlowska, I. Effect of atmospheric factors on the incidence of labor. Ginekologia Polska, September 1967, 38(9), 1029-1033.

Wolkomir, R. Biometeorology seeks clues to health. Science Digest, August 1977, 82(2), 30-32.

Varney, Helen. Nurse-midwifery. Boston: Blackwell Scientific Publications, Inc., 1980.

Vigh, S. Department of pediatrics, United States Air Force Hospital Hill, Hill Air Force Base, Utah. Interview, October, 1980.